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ABSTRACT

This ninth edition of the Rehabilitation Research and Training (RT) Centers reports the FY 1979 research activities of nineteen RT Centers (eleven medical, three vocational, three mental retardation, and two deafness). These research activities focus primarily on the areas of severely handicapped and independent living rehabilitation. The 283 abstracts included in this directory are organized under the RT Centers, which are located at the following institutions: New York University, University of Minnesota, University of Washington, Baylor College of Medicine, Emory University, Tufts University, Temple University, The George Washington University, University of Colorado, University of Wisconsin, University of Arkansas, University of West Virginia, University of Oregon, University of Alabama in Birmingham, Northwestern University, Texas Tech University, University of Wisconsin-Stout, University of California at San Francisco, University of North Carolina at Chapel Hill, and Boston University. Preceding the abstracts under each RT center are listings of that center's core areas of research, completed projects, continued projects, discontinued projects, new projects, and proposed projects. Each abstract includes project objectives, methodology, findings, and applicability. The name of the principal investigator, status of the research activity, and relevant fiscal data are included in bolder type. Both a subject index and principal investigator's index are provided. (LRA)

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Research

Directory of the Rehabilitation Research and Training Centers

Fiscal Year 1979

National Institute of Handicapped Research
Office of the Assistant Secretary for Human Development Services

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U.S. DEPARTMENT OF HEALTH,
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INTRODUCTION

This ninth edition of the **Research Directory of the Rehabilitation Research and Training Centers (FY-79)** has been prepared for local, national, and international rehabilitation service agencies, institutions, and consumer groups. Comprised of 283 research abstracts of the coordinated efforts of nineteen rehabilitation research and training centers (11 medical, 3 vocational, 3 mental retardation, and 2 deafness), it represents another of many endeavors by the Special Centers' Information Exchange Program to organize and disseminate new knowledge and to reduce the gap between the production of research findings and their dissemination. Also included are core area descriptions of the two newest RT centers, the University of North Carolina at Chapel Hill Blindness Rehabilitation RT Center (RT-24) and the Boston University Rehabilitation Center in Mental Health (RT-25).

Focusing on priority areas of severely handicapped and independent living rehabilitation, these vital programs of the recently organized National Institute of Handicapped Research discover new ways to improve rehabilitation methodology and service delivery systems, reduce or stabilize handicapping conditions, and maximize social and economic independence; and secondly, promote the use of new knowledge through training programs. Other responsibilities of the RT Center network include increasing rehabilitation personnel in fields where acute manpower shortages exist, training rehabilitation research and service personnel, incorporating rehabilitation education into university undergraduate and graduate curricula, and improving skills of rehabilitation professionals, aides, volunteers, consumers, and others involved in the rehabilitation process. The primary means for achieving these objectives are short- and long-term inservice and continuing education programs including seminars, workshops, courses of study, conferences, and demonstrations.

For each abstract, researchers have supplied project objectives, methodology, findings, and applicability. The name of the principal investigator(s), status of research activity, and relevant fiscal data are printed in **bold type**. Both a subject index and a principal investigator index are provided to permit easy location of individual abstracts. Accession numbers are assigned to each abstract.

The project director's name and the address of the center can be found at the beginning of each center's research listing and again at the end of the directory where they are accompanied by the name of the director of research. **Requests for information about individual research projects should be addressed directly to the project director of the appropriate center.**

Other Special Centers Office publications include the INFORMER, a quarterly journal which reports news, technological developments and upcoming training activities of the NIHR Special Centers; and the annual **Publications and Audiovisual Aids Directory of the Rehabilitation Research and Training Centers**, an extensive bibliography of materials produced by or available from the rehabilitation research and training centers. For information about these publications write to Department of Health, Education, and Welfare - National Institute of Handicapped Research, Special Centers Program, Mary Switzer Building, Washington, DC 20201.

Joseph Fenton, Ed.D.
Special Assistant to the Director
National Institute of Handicapped Research

MAR 04 1980

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**New York University (RT-1)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Orthotics-Prosthetics

Activities designed to yield immediate and practical improvements in the design and fitting of devices to aid amputees, as well as patients suffering from neuromuscular and/or skeletal disorders.

Neuromuscular Diseases

Activities designed to develop and apply new findings to aid in the rehabilitation of individuals with neuromuscular malfunction. These activities include evaluation techniques, research in neurophysiology and electrodiagnostics, with continuing application to the patient's functional abilities.

Behavioral Science

There are three foci to this program: (a) Psycho-social behavior, (b) Accountability, and (c) Perceptual-cognitive disturbances in brain damaged persons. The program currently focuses on assessment intervention techniques and on the development of "rehabilitation indications."

Cardiopulmonary

Activities designed to aid in the remediation of deficits originating from respiratory and cardiac disorders. This includes both diagnostic and treatment aspects.

Bioengineering

Activities designed to meld engineering and medicine in the solution of disability related problems.

Regional Spinal Cord Injury Center

All of the above core areas interact and interface with the Regional Spinal Cord Injury Center (at the Institute of Rehabilitation Medicine and the Department of Neurosurgery, New York University Medical Center).

NEW YORK UNIVERSITY MEDICAL CENTER

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COMPLETED

ABSTRACT NO.

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Work Classification of Patients with Obstructive Pulmonary Diseases Following Rehabilitation (A. Haas, M.D.)	002
Orthotics and Prosthetics Design Improvements (H.R. Lehneis, Ph.D.)	003
Sympathetic Activity and the Metabolism of Biogenic Amines in Spinal Cord Injured Patients (N.E. Naftchi, Ph.D.)	004
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Evaluation of Functional Ability and Training Efficiency in Chronic Obstructive Pulmonary Disease (H. Pineda, M.D.)	024
The Effects of Resistive Exercises in Improving Respiratory Function in COPD and Neuromuscular Disease (A. Hass, M.D.)	025

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Development of Transfer Devices for High Quadriplegic Patients
 Orthotics and Prosthetics Design Improvement
 Zinc Sulphate in the Treatment of Various Skin Disorders
 Bone Mineralization in Spinal Cord Injured Man: A Biochemical and Radiologic Investigation
 Modular Hyperbaric Oxygen Treatment of Pressure Sores and Traumatic Lesions of the Torso
 Electronic Anal Sphincter for Fecal Incontinence Control and Barium Enema Examination of Disabled
 Persons
 Feedback Control Systems for the Paralyzed

PROPOSED

Clinical Engineering and Work Related Evaluation of Stationary Standup Frames and Standup Wheel-
 chairs for the Disabled
 Development of a Servo-Mechanical Control Device for the Severely Physically Handicapped Driver
 Computer Technology in the Field of Technical Aids to Optimize Service, Both Directly and Indirectly, for
 Maximal Functional Independence of the Physically Impaired Population
 Investigation of the Current Status of Externally Energized/Myoelectrically-Controlled Orthotics and
 Prosthetics Systems and Identification of Applicable Technology in Industry
 A Biochemical and Radiological Investigation of Osteoporosis in Spinal Cord Injured Humans
 Hip Splint and Pelvic Support for Management of Impending or Treatment of Existing Pressure Sores of the
 Sacral Area
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 Functional Changes of Endocrine Glands in Spinal Cord Injury

001 Longitudinal Study of the Effect of Rehabilitation on Factors Such as Job Placement, Maintenance of Employment of Patients with Obstructive Pulmonary Disease

Principal Investigator: Albert Haas, M.D.
Status: Completed
Dates: January 1970-December 1977
Cost: Annual \$13,583 Projected Total \$177,000
RT Annual \$8,557 RT % of Annual Total 63%
Annual Report Reference: #17, Page 9, R-49

OBJECTIVES: This longitudinal study was designed to demonstrate the practicality and effectiveness of a properly planned and implemented rehabilitation program for COPD patients. The area of particular concern is the improvement of their psychosocial and vocational status.

METHODOLOGY: Our basic purpose was to examine the population served by a large municipal hospital for chronic obstructive pulmonary disease to determine what percentage, if any, does not really need welfare support because they are capable of being rehabilitated for remunerative work. Of the more than 900 patients we have screened over the past seven years, a total of 191 (149 male and 42 female) demonstrate the potential for long-term employability.

FINDINGS TO DATE: As far as vocational rehabilitation is concerned, the COPD patients may be divided into five categories based on functional capacity and activity classification.

FUNCTIONAL CAPACITY CLASSIFICATION FOR PATIENTS WITH COPD

Class COPD patients with **ability** to carry out normal physical activities not restricted by work activities
I. and conditions such as sudden temperature changes, atmospheric fumes, and emotional stress.

They are dyspneic only on strenuous activities.

Class COPD patients with **slight inability** to perform normal physical activities. They are somewhat
II. restricted by strenuous work activities and conditions such as sudden temperature changes, atmospheric fumes, and emotional stress.

They are dyspneic on stair climbing.

They are not dyspneic on level walking.

They are not dyspneic on performance of ADL.

Class COPD patients with **considerable inability** to carry out normal physical activities. They are con-
III. siderably restricted by work activities and conditions such as sudden temperature changes, atmospheric fumes, and emotional stress.

They are dyspneic on stair climbing.

They are not dyspneic on level walking (they can walk 1½ blocks at their own pace without stopping).

They are not dyspneic on performance of some of the ADL.

Class COPD patients with **low ability** to carry out normal physical activities. They are markedly restricted
IV. by work activities and conditions such as sudden temperature changes, atmospheric fumes, and emotional stress.

They are dyspneic on stair climbing.

They are dyspneic on level walking (can walk ½ city blocks at their own pace without stopping).

Class COPD patients with **maximum inability** to carry out normal physical activities.
V.

They are severely restricted by work activities and conditions.

They are dyspneic at rest.

They are confined to wheelchair and bed.

They are unable to carry out ADL and are completely dependent on others.

ACTIVITY CLASSIFICATION FOR PATIENTS WITH COPD

- Class COPD patients whose normal physical activities and work conditions such as sudden temperature changes, atmospheric fumes, and emotional stress need **not be** restricted.
- Class COPD patients whose normal physical activities and conditions such as sudden temperature changes, atmospheric fumes, and emotional stress require **slight restriction**.
- Class COPD patients whose normal physical activities and work conditions such as sudden temperature changes, atmospheric fumes, and emotional stress require **considerable restriction**.
- Class COPD patients whose normal physical activities and work conditions such as sudden temperature changes, atmospheric fumes, and emotional stress require **severe restriction**.
- Some patients cannot use public transportation (they need taxis or private car transportation).
- Class COPD patients whose normal physical activities and work conditions such as sudden temperature changes, atmospheric fumes, and emotional stress require **maximum restriction**.

They cannot use public transportation.

APPLICABILITY: The result will constitute a final report and a clarification of who should undertake the application of rehabilitation medicine, the chest physician or the rehabilitation medicine specialist, will be determined. It is also anticipated that step-by-step comprehensive, all-inclusive care will be worked out and accepted by the different departments of rehabilitation medicine in this country. The findings of this study are included in the new book to be published by Williams and Wilkins, **Pulmonary Therapy and Rehabilitation**.

002 Work Classification of Patients with Obstructive Pulmonary Diseases Following Rehabilitation

Principal Investigator:	Albert Haas, M.D.	
Status:	Completed	
Dates:	January 1970-December 1977	
Cost:	Annual \$10,741 RT Annual \$7,444	Projected Total \$200,000 RT % of Annual Total 69%
Annual Report Reference:	#17, Page 18, R-53	

OBJECTIVES: This project demonstrates that a comprehensive, well-planned rehabilitation program based on realistic and individualized patient goals can achieve significant and enduring effects. It also demonstrates that a multi-disciplinary approach coordinated under one roof is indispensable to a successful rehabilitation effort. A dynamic rehabilitation plan has been constructed, indicating the step-by-step application of such a well-organized program. The study also resulted in the development of work classification categories based on the following energy-cost fields: low, medium, high, heavy.

METHODOLOGY: Two groups of patients, experimental and control, have been selected for this study. Each group contains 125 patients with a ratio of 4 males to every female. The patients in both groups undergo a routine x-ray, clinical and laboratory evaluation, including pulmonary function testing by spirometry, plethysmography to measure airway resistance and compliance, and a determination of pulmonary diffusion capacity and blood gas determination both at rest and exercise. These tests constitute the baseline study necessary before starting the work classification study. The patients are then prescribed relaxation exercises, postural drainage, breathing exercises, and oxygen exercises. Once these therapeutic exercises have been learned, the patient is given varying work loads starting with a minimum of 300kgm/min. A three minute warm-up period allowing the patient to reach or approximate a steady-state is followed by five minutes of exercise at a chosen work load. Laboratory procedures, based on energy-cost studies, are used to develop a reliable work classification for each patient. Before exercise as reference point, an analysis is made of oxygen consumption while sitting. During the exercises, as well as during the warm-up period, minute-by-minute oxygen consumption heart rate and oxygen debt are measured to determine if and when the patient reaches his breaking point. Upon cessation of the exercise,

heart rate and blood pressure are measured while sitting. A breath-by-breath analysis is made of the expired gas to determine the contracted oxygen debt and the time to recover from it. Blood gas analyses, such as oxygen tension saturation and CO₂ tension, PH and acid-base balance are monitored as well. The tolerated work load is translated into actual work activities in one of the different energy-cost fields, and these activities are then carried out in a workshop setting.

FINDINGS TO DATE: To date 610 patients have been screened for this study. 117 males and 21 females (138 in total) have been chosen with the following results:

1. Basal metabolic rate before the reconditioning exercises ranged from +14, and from +5 after the reconditioning exercises.
2. The range of respiratory exchange ratio was 0.5 to 1.0 before reconditioning exercises, tending to stabilize at 0.7 and 0.8 after these exercises.
3. Patients reached a steady state while at rest but only approached it during exercises. After the reconditioning exercises the patient failed to reach a complete steady state, although the contracted oxygen debt became somewhat smaller and the rate of recovery was shorter. Duration and tolerance to the minimum workload exercises (of 400 kg meters/minute increased by a ratio of 1:3). Similar results were observed when the patient did small assembly work in a sitting position. The heart rate in B.P. remained within normal limits during the appropriate exercises.

Preliminary analysis of the collected data indicates that in relation to cardiopulmonary function, the maximum tolerable work load is 600 kg meters/minute for this patient group. This allows them to complete a 7-hour work day. The work load classifications are defined according to the following: 1) up to 200 kg meters/minute pertains to self-care; 2) 200-600 kg meters/minute pertains to sedentary (such as clerical and assembly work) and light standing jobs (like bench work involving lifting of no more than 2 to 4 lbs. only for short distances). The 54 patients placed in jobs maintained them for from 8-32 months. Seven patients, however, had to discontinue because of acute respiratory infection and undergo another re-evaluation.

FUNCTIONAL CATEGORIZATION OF WORK-ABILITY-POTENTIAL IN COPD PATIENTS

- I. **COPD Patients With No Vocational Handicap With High Degree of WAP.** Patients who can return to their previous occupation after completing a pulmonary rehabilitation program.

If the previous job is no longer open, the patient is referred to regular employment agencies for placement.

- II. **COPD Patients With Some Slight Degree of Vocational Handicap and Lowered WAP.** Patients who have certain vocational limitations which are imposed by the disability and which interfere with the activities and conditions of their occupation.

These patients most of the time can go back to their occupation and can use their skills. However, they need selective job placement. This means matching the patient's skills, knowledge, physical and mental ability, aptitudes, traits, interests, and physical limitations with the physical demands of the job (activities and conditions) at a wage commensurate with wages obtained for the same work performed by non-handicapped individuals.

These patients are referred for selective job placement to several non-profit employment agencies that have personnel specializing in the placement of handicapped people.

- III. **COPD Patients With Significant Vocational Handicap and Considerably Lowered WAP.** This category is the most important one, and is composed of those patients who cannot return to their previous occupation because the activities and conditions involved in it may jeopardize their health.

Strenuous activities such as pushing, pulling, and lifting are contraindicated.

Exposure to sudden temperature changes or working in an atmosphere of fumes or excessive dust are also hazardous to COPD patients.

The unskilled worker is also included in this category because his work, without exception, is deleterious.

All patients in Category III require training or re-training in a medically suitable occupation.

IV. COPD Patients With a High Degree of Vocational Handicap and Significantly Decreased WAP.

Patients who cannot withstand work pressures and can do sedentary work **only**. They can commute by public transportation, have work tolerance ranging from a few hours to full-time, with some interruptions for rest or the use of nebulizer, have skills or need retraining.

Sheltered workshops provide proper employment opportunities for these patients. In sheltered workshops patients are engaged in various types of work, such as electronics, assembly work, sewing machine operation, clerical work, etc.

V. COPD Patients With Maximum Vocational Handicap and Maximally Decreased WAP: The Homebound Category.

Patients who cannot use public transportation; they can do sedentary work **only**. They have a work tolerance ranging from a few hours to partial or full work tolerance with intermittent interruptions for rest or use of nebulizer or respirator. These patients cannot perform ADL. They are confined to wheelchairs, have good manual skills that could be used in sedentary homebound employment. The Office of Vocational Rehabilitation (O.V.R.) provides homebound training for this category of patients in suitable skills in their own homes. It also provides work, materials, and pick-up and delivery services. Homebound training preserves the patient's energy, otherwise used for commuting, and the piecework enables him/her to work at his/her own pace.

In this category are also included patients whose rehabilitation target is self-care.

The past year was taken up by tabulating the findings and setting up the classification of work capacities. The accuracy of this work classification was confirmed by the 138 patients participating in this study.

Patients in all five categories underwent a complete Pulmonary Rehabilitation Program which consists of energy relaxation exercises, postural drainage, breathing exercises, oxygen reconditioning exercises, vocational and psychophysiological counseling.

APPLICABILITY: Patients with COPD are generally unable to return to and maintain steady employment because most of the present rehabilitation programs are not properly planned and vocational goals are inappropriately chosen. Successful vocational rehabilitation is contingent upon a reliable work classification to determine the occupational field in which the patient can successfully maintain a favorable status. These work classifications also provide a tool for determining the extent of an individual patient's capacity for successful retraining. One can then discriminate between those patients in whom the investment of retraining funds would be reasonably worthwhile and those in whom such an investment would not be productive.

003 Orthotics and Prosthetics Design Improvements

Principal Investigator:	H.R. Lehnis, Ph.D.	
Status:	Completed	
Dates:	October 1975-October 1978	
Cost:	Annual \$59,750 RT Annual \$50,739	Projected Total \$479,664 RT % of Annual Total 92%
Annual Report Reference:	#17, Page 144, R-59	

OBJECTIVES:

1. **Pressure Mapping:** To establish and test a clinically applicable method of graphically quantifying static pressure over large complex surfaces at all points simultaneously.
2. **Universal Terminal Device:** A prosthetic terminal device is being developed that provides function similar to that of a hook but looks like a hand. This is to eliminate that stigma associated with the appearance of a hook, yet to provide the superior prehensile function of a hook.
3. **Electric Arm Orthosis:** A powered orthosis is being developed that provides prehensile function as well as essential degrees of freedom for arm functions to allow for needs of Activities of Daily Living and to reach certain vocational goals.

METHODOLOGY: Pressure Mapping, Universal Terminal Device and Electric Arm Orthosis. Pressure

mapping was completed and the final report submitted in last year's report. This year's report is concerned with the remaining two projects, universal terminal device, and electric arm orthosis.

Universal Terminal Device. Subject population in this project consists of below-elbow and above-elbow amputees, rather than higher levels of amputation since the B/E and A/E amputee is a generally more active user of his prosthesis than higher level amputees. In addition, their vocational potential is greater in general. Testing procedures are standard procedures used in occupational therapy in training amputees which record performance in standard tasks expected of the amputee. In addition, a questionnaire has been developed which aims at a comparative evaluation between standard terminal devices and the universal terminal with regard to performance from the patient's point of view, as well as acceptance and convenience.

Electric Arm Orthosis. The subject population in this project are quadriplegics above C-5, i.e., who are unable to place their hand or arm in space and do not have prehension. The age range is between 18 and 65, i.e., patients who have either college training or vocational potential. An objective evaluation of both designs by an independent institution is also planned.

1. **Pressure Mapping.** The pressure transducer system can be focused at various pressure ranges depending on concentration of reactants, the stacking arrangement, the pressure exposure intervals, the moisture content, and the reactant type. The following sample arrangement was used to evaluate the cut-out board (described in Section 8, Methodology & Procedures):

- a. Stacking arrangement and reactant composition (by weight): first layer—Saran Wrap; second layer—plain urethane foam, 1/16" thick, 50 pores per inch; third layer—acid indicator suspended in plain foam. Indicator consisted of 1% Allied Color Precursor No. 1 and 6% glycerin in ethylene glycol; fourth layer—10% citric acid and 1% glycerin in water suspended in plain foam; fifth layer—Saran Wrap
- b. Pressure was steadily applied to the transducer for 15 seconds
- c. Monitoring range—0.5 to 5 psi
- d. The layers are separated after pressure exposure and either compared with calibration for immediate quantitative information or photographed with calibration to preserve the response.

2. **Universal Terminal Device. Patient Testing.** During this report period, follow-up on one adult patient was done and three pediatric patients were newly fitted with the UTD. Past clinical evaluation of the UTD has been presented in preceding progress reports and copies of this Research Directory.

P.C., a 24-year-old male with a traumatic left below-elbow amputation, continues to use the UTD. He has had the device for 1½ years and recently had the cosmetic glove replaced. A follow-up questionnaire was administered and substantiated by personal interview. He reports using the UTD approximately 40 percent of the time. He still finds that the UTD offers better function in most tasks than the conventional hook and in many tasks that cannot be done with a functional hand. Both light (eating) and heavy (lifting, car maintenance) tasks were specifically mentioned. The increased gripping surface of the device was again emphasized by the patient as a boon to function. He stated the design of the UTD seldom, visually or physically, interfered with function. Cosmetically, the patient continues to consider the UTD better than the alternative terminal devices.

The pediatric included D.H., a 10-year-old boy with a congenital left below-elbow amputation and two girls, C.Z. and A.P., ages 6 and 8½ years, both congenital right below-elbow amputees. Three months after receiving the UTD, D.H. and his parents reported by questionnaire that he uses the device approximately 20 percent of the time. He has experienced somewhat reduced function with the UTD in comparison to a conventional hook, especially with intricate activities such as tying shoes, due to interference from the nonfunctioning fingers. Nevertheless, much improved cosmesis was noted and he wishes to keep the device.

A similar follow-up with A.P. revealed usage of the UTD 50 percent of the time, with a similar report of somewhat decreased function and markedly improved cosmesis in comparison to the conventional hook. No physical obstruction from the design of the UTD was experienced. The patient also wished to retain the UTD.

C.Z. and her mother were interviewed one month after receiving the UTD and reported using the device approximately 60 percent of the time. They reported the same function with both the UTD and conventional hook; however, the patient was not previously an avid hook user. The cosmesis afforded by the UTD resulted in its use primarily at school as the patient manages without the prosthesis at home. She no longer uses the hook. A functional performance evaluation was also performed with C.Z., both one month and seven months after receiving the UTD. She demonstrated active use of the device in holding objects during bilateral activities (e.g., reading, cutting paper) and passively as a stabilizer (e.g., in writing). C.Z. recently received a new cosmetic glove and continues to use the UTD.

3. **Electric Arm Orthosis.** No additional patients have been tested with the EAO during this report period. See previous reports for patient testing and Section 11a, "Discussion," and Section 11b, "Conclusions and Recommendations" for further explanation. (Annual Report 16-P-56801/2-18).

APPLICABILITY: Since this system enables the clinician to predict future pressure-induced skin ulceration and allied difficulties without the use of complex, expensive equipment and additional technical assistance, the efficiency of the rehabilitation process is expected to increase and resultant costs are expected to decrease. Consumers will be the general upper limb amputee population who currently use one or more types of terminal devices.

004 Sympathetic Activity and the Metabolism of Biogenic Amines in Spinal Cord Injured Patients

Principal Investigator:	N. Eric Naffchi, Ph.D.	
Status:	Completed	
Dates:	September 1968-September 1979	
Cost:	Annual \$833,336 RT Annual \$48,737	Projected Total \$939,913 RT % of Annual Total 42%
Annual Report Reference:	#18, Page 298, R-61	

OBJECTIVES:

1. To determine the relationship between cutaneous circulation and catecholamine metabolism in paraplegic and quadriplegic subjects with the purpose of elucidating the cause of trophic skin ulcers and spasticity.
2. To measure the effect of various levels of injury on the metabolism of catecholamines and correlate the degree of derangement in regulatory, integrative and stress functions with concentration of these neurotransmitters and their metabolites.
3. To measure the degree of sympathetic activity in different levels of spinal cord injury.
4. To develop measures for reducing the incidence of decubitus ulcers in the spinal cord injured human.

METHODOLOGY:

1. Catecholamines and their metabolites will be measured in plasma and urine and spinal fluid of cord transected individuals. Various levels of cord transection and their effect on these hormones and neurohormones will be investigated. Methods used include column and bidimensional paper and thin layer chromatography, ultra-violet fluorescent and atomic absorption spectroscopy, and the use of ultracentrifuge scintillation spectrometry and strip scanning for radioisotopic analysis of the hormones and ions involved. Sympathetic activity will be evaluated by reactivity of the patients to exogenously infused norepinephrine, tyramine or angiotensin. Digital calorimetry will be used for the studies on reactivity to norepinephrine or other pressor substances. Gas-liquid chromatography, mass spectrometry and infrared spectrometry will also be employed for separation and identification of unknown compounds.
2. Digital blood flow will be measured calorimetrically and by means of mercury-in-rubber Whitney strain gauge.

3. Heart rate, arterial blood pressure and plasma levels of NE, DBH, C-AMP and cortisol were measured to determine the degree of sympathetic activity in different levels of spinal cord injury.

FINDINGS TO DATE:

1. In seven C5-C7 quadriplegic subjects blood volume was measured by means of double isotope technique, using 125I and 51 Cr. In five other C5-C7 quadriplegic subjects autonomic hyperreflexia was induced by expansion of the urinary bladder by means of water intake. Cardiac output was measured by indicator dilution method and arterial blood pressure by auscultatory technique. During hypertension there was no appreciable change in either cardiac output or cardiac index. By contrast, there was a significant rise in mean arterial blood pressure and total peripheral resistance and a sharp fall in pulse rate. Preliminary studies on blood volume reveal that during hypertension there is a 10% rise in hematocrit but relatively little change in total blood volume. These results indicate that during hypertension there is: (1) an increase in hemoconcentration, probably due to an increase in capillary permeability; (2) hypertension is caused mainly by a pronounced decrease in blood flow of the upper and lower extremities and by a sharp increase in the total peripheral resistance. This marked vasoconstriction correlates with increased activity of serum dopamine- β -hydroxylase, the enzyme responsible for the synthesis of the neuro-transmitter, norepinephrine. This enzyme is released together with norepinephrine during hypertensive stress (Naftchi, N.E., et al., *Frontiers in Catecholamine Research* 1973, pp. 1143-47, Pergamon Press) and is thus an index of sympathetic activity (Naftchi, N.E., et al., *Circ. Res.* 35:850-5, 1974).
2. Reactivity of the digital vascular bed to infused 1-norepinephrine (NE) was measured in 15 subjects with complete physiologic transection of the spinal cord at various levels and was compared with that of 16 normal subjects. At least one hour before the test a continual bladder drainage was insured by means of an indwelling Foley catheter imbedded in Lidocaine gel. Sympathetic nerve discharge was inhibited by indirect heating of the subjects and continuous infusion of trimethaphan camphorsulfonate (TMCS), a ganglion blocking agent. Following the measurement of digital blood pressure and flow in this phase of vasodilation, vasoconstriction was brought about by infusion of NE while the infusion of TMCS continued. Flow-pressure ratios were converted to radius equivalents of digital circulation and the work of vasoconstriction was quantified in ergs per microgram of NE infused per minute. The reactivity of NE in paraplegic subjects with lesions below the T6 dermatome was within the range found for normotensive subjects. In subjects with spinal cord transection above the T6 dermatome, reactivity to NE was more than two-folds greater than that of normotensive and paraplegic subjects with lesion below T6 dermatome. The significance of these findings with respect to denervation supersensitivity and the level of spinal cord lesion is being investigated further.
3. A new radioenzymatic high performance liquid chromatographic method which is sensitive and specific enough to measure dopamine, norepinephrine, and epinephrine simultaneously in 50 microliters of plasma has been developed. We have identified norepinephrine as the causative neurotransmitter involved in paroxysmal hypertensive episodes which accompany autonomic dysreflexia. Furthermore, the concentrations of prostaglandins PGE₂ in arterial blood rise during the attacks of autonomic hyperreflexia which are associated with flushing of the face and neck, chest pain, and headache. The identification of norepinephrine involvement in autonomic dysreflexia provides rationale for the treatment of acute hypertensive crises and long term maintenance of quadriplegic subjects susceptible to hypertension.

Prostaglandins PGE₂ infusions are known to cause facial flushing and headache. This finding in 28 subjects will also aid in treatment of headache by antiprostaglandin agents. During the stress of head-up tilt (30°-40°), heart rate increased in all subjects but the blood pressure dropped significantly in quadriplegic and remained unchanged in control and paraplegic subjects. In 34 subjects studied, both norepinephrine and dopamine- β -hydroxylase increased significantly 20 minutes after tilt. The latter two may be considered good indices of sympathetic activity.

APPLICABILITY: Too frequently, after substantial investments are made in the physical and vocational training of paraplegic and quadriplegic patients, numerous complications arise which necessitate re-hospitalization, frequently for a prolonged period, and thus jeopardize further employment of the patients in their prehospitalization job or a new job following discharge from the hospital. If through the proposed investigation the basic underlying physiological factors which contribute to decubiti, urinary infection, and other similar complications could be identified and possibly

brought under control, the vocational rehabilitation of these severely disabled persons would be greatly enhanced.

005 Functional Changes of Endocrine Glands in Spinal Cord Injury

Principal Investigator: N. Eric Nafichl, Ph.D.
Status: Completed
Dates: September 1974-September 1979
Cost: Annual \$51,276 Projected Total \$399,671
RT Annual \$38,029 RT % of Annual Total 74%
Annual Report Reference: #18, Page 308, R-81

OBJECTIVES: The objectives of this research are to examine critical endocrine function in paraplegic and quadriplegic subjects by means of exact and sensitive tools of radioimmunoassay and gas-liquid chromatography, to assay in blood the major hormones, and to analyze in urine 17-hydroxycorticosteroids, 17-ketosteroids, aldosterone, and reninangiotensin as described in the Methodology.

METHODOLOGY: The ability of ¹³¹I or ¹²⁵I-labelled hormones to compete with unlabelled hormones for antibody has been utilized in the radioimmunoassays for human growth hormone (1), rat (2, 3), human (4), bovine (7), LH, FSH (5), and rat prolactin (6). Purified hormones are iodinated by modifications of the method of Greenwood et al., 1963 (8) using chloramine-T as the oxidizing agent.

In order to determine whether impaired sympathetic nerve response and/or impaired renin release are responsible for orthostatic hypotension in patients with cervical spinal cord lesions, serum dopacine-8-hydroxylase (DBH) activity and plasma renin activity (PRA) were examined during passive tilting in six quadriplegic patients and in six normal control subjects. Serum DBH was measured by an isotopic enzymatic method and PRA by radioimmunoassay. See results under Findings To Date, no. 4.

FINDINGS TO DATE

1. The concentration of testosterone in serum and the level of 17-Ketosteroids in urine of seven paraplegic and nine quadriplegic subjects were measured from the date of onset of the injury and were followed longitudinally once a week for a period of 15 to 30 weeks.
2. From the date of onset until three to eight weeks later, serum testosterone levels were about one-half that of normal controls but reached and remained at about normal levels thereafter. The concentrations of urinary 17-Ketosteroids followed approximately the same trend as that described for serum testosterone. Urinary 17-Ketosteroid levels, however, exhibited sharp weekly fluctuations from one-half below to low normal values. The latter results may suggest a derangement in regulation of synthesis or metabolism of androgens in spinal cord injured subjects.
3. Urinary 17-Ketosteroid levels were lower than normal values in paraplegic subjects. In quadriplegic subjects, however, 17-Ketosteroid excretion remained approximately normal. The results suggest a derangement in the regulation of synthesis and/or metabolism of neurotransmitter and androgens due to a disturbance in hypothalamic-pituitary-gonadal axis.
4. Following head-up tilting, quadriplegic subjects demonstrated a prompt significant decrease in mean arterial pressure and increase in heart rate. DBH and PRA both increased significantly 15 minutes following tilt. In normal subjects, although heart rate increased, mean arterial pressure was unchanged; DBH and PRA did not increase significantly during head-up tilt. The findings of increased DBH during tilt-hypotension in quadriplegic patients provide evidence that reflex sympathetic nerve stimulation persists despite cervical cord transection. Increased PRA may be attributed to decreased renal perfusion pressure and increased sympathetic stimulation during tilt hypotension. The significance of these data is that they suggest that orthostatic hypotension in quadriplegics cannot be attributed solely to the failure of the sympathetic nervous system or the renin-angiotensin system to respond to the stimulus of orthostasis.

APPLICABILITY: Since the integration of the most important biological functions in the body is carried out by the autonomic and central nervous systems as well as the endocrine glands, it is urgently necessary that we study dysfunctions of the feedback mechanism between various endocrine glands to be capable of reversing or preventing some of the serious complications incurred by paraplegic or quadriplegic subjects. For instance, there is no explanation as to why some patients with spinal cord injury develop stress intolerance, gynecomastia, testicular atrophy, amenorrhea, etc., all manifestations of disturbed functioning of the endocrine system.

005 Evaluation of Various Electronic Devices to Increase Mobility and Independence of Very High Level Quadriplegic Patients (above C5)

Principal Investigator:	Heiner Sell, M.D.	
Status:	Completed	
Dates:	October 1974-September 1977	
Cost:	Annual \$132,023 RT Annual \$117,226	Projected Total \$700,000 RT % of Annual Total 89%
Annual Report Reference:	#41, Page 96, R-82	

OBJECTIVES: The general objective of this project was to determine which electronic equipment can best be utilized in the rehabilitation of the severely disabled quadriplegic by the evaluation of various types of such equipment.

METHODOLOGY: This study was undertaken to determine the usefulness of electronic assistive devices within the rehabilitation of very high level spinal cord injured patients. A total of 39 high level quadriplegic patients participated in the comparative clinical testing of a total of 21 different devices. Evaluated equipment included locomotion systems, environmental controls and type-writer control systems. Patient interfaces evaluated included pneumatic ("breath"), audio, thermal, pressure and speech recognition ("voice"). In-hospital testing of all devices, followed by post-discharge testing of the same and/or additional devices at home or school, permitted comprehensive assessment of actual functional value of the device as well as suggested modifications for device improvement.

FINDINGS TO DATE: Findings indicate that high level quadriplegics can successfully utilize electronic assistive devices and will attain greater independence through such use. The devices which are more successfully utilized are those that patients consider to be acceptable, which fulfill functional needs and which perform in a reliable manner. Findings indicate that only 2 of the evaluated commercial devices currently meet those requirements to a degree that purchase of same can be considered cost-effective (Prentke-Romich ECU-1, Prentke-Romich ADT-5A).

It is anticipated that utilization of findings by manufacturers for device improvements and by designers for device development will result in an increased number of commercial devices meeting the functional requirements of reliability, desirability and suitability for the target group.

APPLICABILITY: A leading international manufacturer of wheelchairs has accepted the 1-tube IRM Breath Control for production. Three prototypes from them are projected to be ready for in-house testing as a preliminary to national marketing.

The manufacturer of one environmental control device (Robot) has reported that our evaluation findings are being considered in the redesign of their device.

007 Demonstration of Benefits of Early Identification of Psychosocial Problems and Early Intervention Toward Rehabilitation of Cancer Patients

Principal Investigator:	Leonard Diller, Ph.D.
Status:	Completed
Dates:	June 1975-December 1978

Cost:

Annual \$82,795
RT Annual \$36,322

Projected Total \$716,670
RT % of Annual Total 44%

Annual Report Reference:

#18, Page 175, R-84

OBJECTIVES: To determine (1) the relationship between classification of rehabilitation goal and classification of severity of disease; (2) the impact of cancer on patient's ADL functioning; (3) the relationship between ADL change and patient's self report of psychosocial problems.

METHODOLOGY: Three hundred and eight individuals, with cancer of the breast (N=98), lung (N=83) and skin (melanoma) (N=127) were assessed within 48 hours of their initial cancer-related hospital admission. Half of the patients were evaluated and then received a systematic program of psychosocial rehabilitation (intervention group), while the remaining half only received psychosocial evaluation (control group).

The format of these assessments, problem-oriented, structured clinical interviews with selected psychometric tests is similar to that used in Phase I of the project. However, the following changes were made in order to make the interviews more appropriate for longitudinal assessment:

1. Based on the findings of Phase I, the problems surveyed were revised. Those that occurred infrequently were eliminated while others were added.
2. Not all of the same problems were surveyed at each time interval. For example, inquiries about side effects of treatment prior to their having taken place were not appropriate, and asking about the adequacy of nursing staff six months post-hospital discharge was thought to be of little value.

The Psychosocial Intervention Program is based on the individual needs of each patient. The actual nature and flow of interventions is documented in psychosocial problem-oriented records (POR).

FINDINGS TO DATE: Results*

1. Evaluation instruments were developed which were sensitive to the course of psychosocial treatment of the cancer patient.
The majority of difficulties reported in the evaluation instruments were treated by the intervention program.
Psychosocial interventions were focused on those problems that were most intensely experienced by patients.
2. Psychosocial intervention improved the adjustment of cancer patients.**
Psychosocial intervention effectively ameliorated some of the psychosocial problems that were reported by patients.
85% of those in the intervention group who were working at hospital admission had returned to work by T4 (6 months post-hospital discharge). In contrast, this was true for only 67% of the control patients.
There was an increase in the frequency of solitary activities (reading, TV watching, napping) in the control group.
Rates of recovery of heightened levels of affect (anxiety, hostility, and depression) were accelerated in the intervention group, in that they reached their nadir at T2 and then remained stable.
Those receiving intervention were more realistic in their outlook.
The intensity with which psychosocial problems were experienced at T4 was a function of initially heightened levels of affect (anxiety, hostility) in the control group but in the intervention group was related to the seriousness of the disease.
3. Specific variables that are barriers to rehabilitation were identified.
Psychosocial intervention was effective in removing these barriers.
4. Criteria were developed to predict those patients who are "at risk" to develop psychosocial problems later in the course of the disease.
* A more detailed description is presented in the Final Report.

** Results indicate no significant demographic differences between the control and intervention groups. Similarly, the distribution of medical variables (e.g., prognosis, staging of disease, type of medical treatment administered, etc.) was similar.

APPLICABILITY: A 1974 study sponsored by Cancer Care indicated that 75% of all the patients studied had psychosocial problems. It is a known phenomena in rehabilitation that psychosocial difficulties mediate the success of rehabilitation efforts. Therefore, knowledge relating to the interface between ADL status, rehabilitation goal, and the presence of psychosocial problems will enable rehabilitation workers to more effectively focus their efforts.

008 Motor Conduction Velocity Measurement in Myotonic Dystrophy

Principal Investigator:	Arthur Eberstein, Ph.D.	
Status:	Completed	
Dates:	September 1975-September 1978	
Cost:	Annual \$72,742 RT Annual \$60,000	Projected Total \$195,000 RT % of Annual Total 82%
Annual Report Reference:	#17, Page 280, R-85	

OBJECTIVES: The objectives of this study were to determine whether nerve conduction in patients afflicted with myotonic dystrophy or myotonic congenita is impaired, and whether there is any nerve involvement of parents and siblings of these patients.

METHODOLOGY:

1. Patients with clinical and electromyographic findings characteristic of myotonic dystrophy or myotonic congenita were accepted as subjects for this study. Both female and male patients of all ages were tested. The population sample consisted of at least 50 subjects. Control values were those already established in this laboratory.
2. Conduction velocities were determined in the median, ulnar and peroneal nerves and sensory latency times in the median and ulnar nerves of each subject. The procedure followed has been described in the book by Goodgold and Eberstein (Electrodiagnosis of Neuromuscular Diseases, Williams and Wilkins, 1972, Ch. 6). Essentially, nerve conduction velocities of motor nerve fibers are determined from measurements of the latencies of potentials evoked in the muscle after nerve stimulation at two different points along its length.
3. The mean conduction velocity and mean latency time as well as standard deviations were calculated for each nerve, and the T-test applied to the means of corresponding nerves (normal vs. myotonic patients) to determine the significance of the difference.

FINDINGS TO DATE: Myotonic muscular dystrophy is a multi-system disorder with autosomal dominant inheritance. In the past, peripheral nerves were considered to be normal; however, recent studies have shown that nerve conduction may also be impaired. The current study describes the results of nerve conduction measurements in motor and sensory fibers of the median, ulnar and peroneal nerves of 39 patients with myotonic dystrophy, 29 with Duchenne dystrophy and 2 with myotonia congenita. Terminal latencies and motor conduction velocities in Duchenne dystrophy and myotonia congenita were within normal limits. Median and ulnar conduction velocities were normal in myotonic dystrophy, whereas, the peroneal nerve latency and conduction velocity were statistically abnormal. The impaired conduction could not be correlated with severity of the disease.

APPLICABILITY: The knowledge that the nerve is or is not involved in the disease process is important to the clinician as well as the scientist. The clinician may use this information to improve the differential diagnosis of muscle disease, prepare a program of rehabilitation and, possibly, as an early indicator of abnormality. Early and accurate diagnosis may be essential to successful treatment and, at least, partial reversal of the disease process.

Furthermore, results of this project may be utilized in the growing controversy regarding the pathogenesis of the myopathies. Any evidence that can be presented to resolve this problem is significant for the entire medical community.

009 Electronic Anal Sphincter Stimulation for Fecal Incontinence and Barium Enema Examination of Disabled Persons

Principal Investigator: Boguslav H. Fischer, M.D.
Status: Completed
Dates: October 1975-October 1980
Cost: Annual \$11,485
RT Annual \$6,411
Projected Total \$41,571
RT % of Annual Total 56%
Annual Report Reference: #18, Page 334, R-95

OBJECTIVES:

1. Construction of properly shaped anal plug.
2. Construction of stimulating generators.
3. Modification of existing safety overflow system, by elimination of kinking problems of the tubing and construction of an over-flow reservoir.
4. Construction of open-end manometric system permitting direct measurement of existing pressures within the colonic lumen during barium enema examination.

METHODOLOGY: Patients were selected for New York University Medical Center both on in- and out-patient basis. They are divided into three groups.

First Group: Patients who present fecal incontinence as a major debilitating and socially handicapping factor in their rehabilitation and return to productive life. Stimulation of the anal sphincter muscle was administered after appropriate EMG study in order to obtain objective information. The response and degree of restoration of fecal continence was monitored by close follow-up of the patient either on ward or on an out-patient basis.

Second Group: Patients with essentially intact nervous system, undergoing rehabilitation treatment, and who for various reasons could not retain the contrast material during X-ray examination using standard methods including injections of Valium and Glucagon. Both in- as well as out-patients were accepted in this study. The study was performed in close cooperation with the Department of Radiology, New York University Medical Center.

Third Group: Patients with a central nervous system disorder, undergoing rehabilitation treatment, who were unable to retain the barium enema during X-ray examination for abnormal pathology.

FINDINGS TO DATE: In this project the externally placed electrodes were used exclusively. The stimulating current characteristics are as follows:

Frequency:	500 Hertz
Voltage:	0-20 Volts
Impulse:	square, bipolar
Impulse duration:	0.5 milliseconds

Easy fatigability of the anal sphincter muscle was noticed when the impulse duration was shorter than 0.5 milliseconds. Discomfort of the patients during actual stimulation was eliminated by increasing the frequency to 500 Hertz.

The method proved to be safe, relatively easy to apply and control. There were no failures in barium enema examinations in 22 patients, eleven of whom presented a severe central nervous system disorder. All these patients were unable to retain the barium enema during previous examinations using standard methods rendering this extremely important and simple diagnostic procedure useless. Two cancers of the colon were detected. They escaped diagnosis during prior examinations including biopsy. The method reduced or eliminated further medical investigations resulting in accelerated return of the patients to active rehabilitation programs or in an earlier discharge from the hospital. The barium enema plug and stimulator were patented (U.S. patent #394 3 938). The patient was assigned to the New York University Medical Center. The equipment is manufactured by the Electro-Catheter Corporation, Rahway, New Jersey.

APPLICABILITY: It is expected that the development of proper anal sphincter stimulation technic can be of enormous help to the debilitated patient as well as instrumental in barium enema examinations in those patients who cannot retain the contrast material.

010 Bone Mineralization in Spinal Cord Injured Man: A Biochemical and Radiologic Investigation

Principal Investigator: N. Eric Naffchi, Ph.D.
Status: Continuing
Dates: September 1969-September 1979
Cost: Annual \$34,178 Projected Total \$531,231
RT Annual \$25,086 RT % of Annual Total 73%
Annual Report Reference: #18, Page 285, R-60

OBJECTIVES:

1. To determine the causes of excessive bone demineralization in patients with paralysis due to spinal cord lesions.
2. To prevent demineralization.
3. To arrest and treat complications of osteoporosis by controlling calcium and phosphate metabolism.
4. To elucidate the cause of myositis ossificans and thereby prevent the restrictive, debilitating effects, either by inhibiting its formation, or once formed, cause its resorption or maturation by pharmacologic means.

METHODOLOGY:

1. The objective of this study is to arrest bone absorption and favor bone deposition by means of administering several therapeutic agents separately and in combination. The pharmacologic agents will be inorganic phosphates (Hyper-Chos. K), diphosphonates, and thyrocalcitonin. The following techniques will be employed to determine successful therapy: (a) chromium corrected phosphate, calcium, magnesium, nitrogen balances will be studied for two consecutive four-day periods after appropriate equilibration; (b) radiographic measurement of metacarpal and metatarsal cortical thickness; (c) quantitative, serial measurement of forearm and leg bone density by means of gammaphoton densitometer.
2. The results of quantitative serial measurements of bone density by simultaneous radiographic and gamma-photon densitometry and ¹⁸F uptake will be correlated with mineral balance and collagen turnover in acute and chronic quadriplegia and paraplegia. These results, in turn, will be compared in patients with a different level of spinal cord transection in acute, recovery, and chronic phases in order to determine the effects of various levels of transection of spinal cord on skeletal demineralization.

FINDINGS TO DATE:

1. Bone mineral content was measured by single photon absorptiometry using a modified Packard bone densitometer with ¹²⁵I as the source. In 45 hemiplegic subjects, matched for sex and age, the bone density was compared bilaterally on the radius and ulna two and four centimeters above the wrist. The non-paralyzed side served as a control for the paralyzed side. There was an equivalent number of right-dominant, right-paralyzed and left-dominant, left paralyzed subjects. The results indicate a consistent, general loss of bone mineral on the paralyzed side compared with the non-paralyzed side. Right-dominant, left-paralyzed patients showed a greater loss of bone density than left-dominant, right-paralyzed subjects. The absorption ratio of the paralyzed versus the non-paralyzed sides revealed that there was a 6.8% and 7.3% decrease in the average bone density at four centimeters and two centimeters above the wrist, respectively. There was a progressive loss of bone mineral content relative to time after the onset of paralysis, amounting to an average of 5% from both sites measured approximately three months after onset of injury.

The effect of physical and drug therapy on the rate of demineralization following paralysis remains to be elucidated.

2. This study was undertaken to assess the feasibility of the osteodensitometry for determination of bone mineral content. Hemiplegic subjects were chosen as simpler models in order to compare the paralyzed with non-paralyzed arm and set-up the technique for spinal cord injured subjects who are more challenging to study. The progressive loss of bone mineral content relative to the time after the onset of paralysis will be measured as above in spinal cord injured subjects in order to determine the extent of bone demineralization and the effect of drug treatment.
3. Urinary excretion of magnesium and calcium was measured in 11 quadriplegic and 7 paraplegic subjects from the date of the onset of injury and was followed longitudinally once a week for a period of 15 to 24 weeks. Both groups of subjects excreted calcium and magnesium significantly higher than normal during the first eight weeks after the injury. The mean levels gradually decreased towards but did not reach normal levels 24 weeks later. The excretion of calcium in both quadriplegic and paraplegic subjects was of the same magnitude but the excretion of magnesium in paraplegic subjects was about 75% of that in quadriplegic subjects.
4. Dysfunction of mineral metabolism has been studied in our laboratory in order to elucidate the cause of the disorder and thereby correct the problem by the appropriate therapy. 120 paraplegic rats and 103 paraplegic and quadriplegic human subjects were investigated. Balance studies of calcium, magnesium and phosphorus were carried out in paraplegic rats and were compared with the sham-operated, age-matched litter mates. Measurement of the excretion of the above cations and anions including that of hydroxyproline was carried out in human subjects longitudinally immediately after the onset to four months post injury in chronic subjects chosen at random up to six years after the injury. The results in human subjects were similar to those in animal models and showed that bone resorption starts rapidly after the onset of injury leading to osteoporosis.

Thyrocaltitonin therapy in rats reversed the negative calcium, magnesium and phosphorus balances and changed the survival rate of animals, which died mainly from hydronephrosis, from 25% to 85%. Studies in man involving therapy with thyrocaltitonin and diphosphonates is anticipated.

Our findings of excessive bone mineral loss which commences almost immediately after the onset of spinal cord injury is very significant. In humans, within six to eight months after the injury, the process of bone resorption renders the subjects osteoporotic in addition to causing other side effects such as renal calculi and periarticular bone formation. We have found that the immediate treatment of spinal cord injured animals with thyrocaltitonin reverses the negative mineral and hydroxyproline balance and increases the survival rate of rats from 25% to 80%. Most of the untreated animals died of hydronephrosis secondary to bladder infections. As a result of this finding in collaboration with the Departments of Neurosurgery and Neuroradiology, we are initiating the treatment of acute spinal cord subjects with thyrocaltitonin. The patients will be monitored both biochemically and radiologically using computerized tomography for bone scanning. These techniques may be utilized in other rehabilitation centers and may find further use in treatment and follow-up of post-menopausal osteoporosis and Paget's disease.

APPLICABILITY: Calcium and phosphate metabolism is deranged in spinal cord injured humans. The associated complications, kidney stone, myositis ossificans, bone pain and fractures limit the independence, employability and rehabilitation of spinal cord injured man. In the present study, under dietary control, calcium and phosphate metabolism will be determined before and after specific treatment and correlated with bone density measurements and other biochemical findings. These treatments have proven successful in arresting bone resorption and favoring bone deposition in animals and some humans with bone fractures. The development of methods for the control of calcium and phosphate metabolism in spinal cord injury is essential in order to reduce debility, protracted and recurrent hospitalization of these patients.

011 Rehabilitation Indicators: A Method for Enhancing Accountability and the Provision of Rehabilitation Service (Rehabilitation Indicators: A Method for Enhancing Accountability)

Principal Investigator: Leonard Diller, Ph.D.
Status: Continuing
Dates: October 1974-October 1979
Cost: Since May 1, 1977 this project has been supported under independent grant RSA #12-P-59047/2.
Annual Report Reference: #17, Page 225, R-88

OBJECTIVES: The RI methodology, when used in rehabilitation settings, will serve several purposes (long term goals):

1. Rehabilitation settings will become **more accountable** through a broader and more objective information flow and improved decision making, in line with the resource provider's expectations; these expectations are stated in terms of access (who is to receive services), process (what is to occur) and outcomes (the types of goals that are viewed as valid).
2. Rehabilitation settings will provide **better** services in that individual client planning, tracking and follow-up can be tied to RI's; also program planning can be more clearly tied to the types of primary goals and instrumental sub-goals addressed within the population.
3. Rehabilitation systems will be able to **define "disability"** in functional terms and define "needs" of the disabled in terms of skills and environmental supports needed to reach goals.

METHODOLOGY: The project will be implemented in three phases: Phase I initial development of RI's (October 1974-May 1977); Phase II: Final development of RI's and field testing (May 1977-October 1979); and Phase III: Demonstration and Utilization/Dissemination (October 1979-).

FINDINGS TO DATE: A lexicon has been developed which consists of three sets of indicators which constitute an objective and hopefully clarified language for rehabilitation. This modified language can be implemented in many ways within varying rehabilitation systems, including the use of the lexicon within a structured interview, an unstructured interview, and/or within an observation paradigm. The particular method selected would depend on factors such as the type of client, the type of rehabilitation services and the type of rehabilitation setting.

The focus of the lexicon is behavioral and observable, but not behavioristic, in that no particular theory of behavior is adopted nor any behavior change methods.

APPLICABILITY: Status indicators, activity indicators and external factor indicators can be used within the process of rehabilitation, utilizing a basic systematic approach. In this approach the rehabilitation indicators would be used to fulfill several purposes, including defining status goals, necessary skills, and external strengths and problems, for the purpose of individual rehabilitation planning, and defining changes in status activities and external factors for evaluation purposes.

012 Diagnosis and Remediation of Deficits in Verbal Abstraction and Visual Information Processing in Brain Damaged Adults

Principal Investigator: Leonard Diller, Ph.D.
Status: Continuing
Dates: October 1975-December 1981
Cost: Annual \$121,606 Projected Total \$860,000
RT Annual \$70,418 RT % of Annual Total 58%
Annual Report Reference: #18, Page 190, R-92

OBJECTIVES: To develop and validate a normative scale and calibrated neuropsychologic module for the differential diagnosis of remediation and prognosis of dysfunctions of visual information processing in various types of brain damaged adults. This will further result in the development of a taxonomy of deficits of visual information processing found in brain damaged adults. These objectives may be broken down in terms of the objectives for each of four sub-studies to be carried out in three years.

Past Objectives:

Study I. The objective of the past year of research was to evaluate the efficacy of a three-stage VIP training module (scan, simultaneity, successiveness) on mild to moderately impaired right brain and left brain damaged stroke patients.

Study II. The objective of the past year of research was to evaluate the efficacy of a training module designed to facilitate V.A. thinking in right and left brain damaged stroke patients.

Future Objectives:

To compare the differential outcomes of conventional medical rehabilitation efforts with one which includes a comprehensive program designed to remediate the cognitive deficits associated with a CVA.

To describe the longitudinal impact of stroke on these two groups of patients relative to a matched group of normal controls.

To differentially describe and predict recovery of function in these two groups of patients from appraisal of data derived from: demographic, clinical neurological examination, CTT scans, psychometric evaluation, and RI evaluation.

To study the relationships among the above mentioned data sets in order to develop typologies which can describe the types of changes expected in subgroups of patients.

METHODOLOGY: This study aims to improve abstract thinking and higher order visual information processing (simultaneity and successiveness) in unilateral brain damaged adults. Each of these aims is pursued through a series of studies involving: (1) the development of criteria for abstract thinking and visual information processing in normals; (2) gathering normative data on hemiplegics; (3) piloting remediation techniques on a small sample of patients; (4) a study in which experimental groups receive training in abstract thinking or visual information processing and controls do not, to see if treatment can impact the criteria. Subjects for abstract thinking will include 48 normals, 48 hemiplegic patients for normative purposes and 60 patients to form experimental and control groups. For the VIP study, 60 normals will be used, 45 hemiplegics will be used for normative purposes and 34 patients will participate as experimentals or controls.

FINDINGS TO DATE: 52 normals (age 45-75) were administered the test battery enumerated below. This was done in order to standardize the battery and derive a set of age appropriate norms. The battery has also been administered to 23 (13 left and 10 right) hemiplegics. 22-37 additional hemiplegics were seen during the next several months in order to complete the standardization process. Approximately 4 months were devoted to pilot studies in training. During 1978 Substudy IV (Training in Visual Information Processing) and Substudy V (Training in Verbal Abstraction) have commenced. To date 57 patients have been seen. This amounts to approximately 50% of the total number of patients projected to be seen in these two substudies. Results indicated that training had both task specific (verbal vs. visual) and general effects.

Test Battery

Full WAIS

Conditional Cancellation (developed by Staff)

Embedded Figures (Ayers)

Cube Analysis (Stanford - Binet)

Perceptual Analysis and Synthesis (Birch & Lefford, 1965)

Autobiographical Statement (developed by Staff)

Parts of the Ravens (selected by Staff)

Parts of the Letter (selected by Staff)

Goldstein Object Sorting Task

Visual Simultaneity (developed by Staff)

SC Visual and Pictorial Similarities (developed by Staff)

Trail Making (Part of Reitan Battery)
Knox Cube
Porteus Mazes
Symbol - Symbol (Jastak)
Visual Digit Span
Bender-Bestall
Metropolitan Achievement Test (Comprehension and Arithmetic)
Simultaneous Recognition (developed by Staff)
Paragraph Titles

APPLICABILITY: Hemiplegia constitutes the largest physical disability group with an estimated prevalence of 200-2,000 per 100,000. Our previous studies have indicated that perceptual disorders common to right brain damage are critical bottlenecks in successful rehabilitation (Diller, et al.) (Lorenz & Cancro).

013 Rehabilitation of Cognitive and Perceptual Defects in People with Traumatic Brain Damage

Principal Investigator:	Leonard Diller, Ph.D.	
Status:	Continuing	
Dates:	April 1978-March 1984	
Cost:	Annual \$144,899 RT Annual \$93,196	Projected Total \$721,000 RT % of Annual Total 64%
Annual Report Reference:	#18, Page 251, R-93	

OBJECTIVES:

1. To assess the efficacy of a pilot demonstration program for chronic traumatic head injured patients.
2. To assess the efficacy of four domains of remedial training which are part of the pilot demonstration program.
3. To assess the effect of the program on the patients by a one-year follow-up study to include psychometric criteria, Rehabilitation Indicators (RI's) and neurologic measures.
4. To predict differential outcome from intake data. The data to be collected include (1) psychometric tests; (2) a problem oriented record and a prescriptive remedial plan (i.e., the specific "action" plan for a given cycle); (3) Rehabilitation Indicators; and (4) neurologic assessment.

METHODOLOGY: The program consists of treatment cycles of ten weeks each. Each cycle includes (1) assessment, (2) orientation, (3) treatment, and (4) reassessment. Since the original proposal was submitted and approved, our experience with a successful pilot program in Israel suggests that it is prudent to plan that each patient will receive two cycles. Therefore, the program consists of four cycles a year. The time between cycles is used for screening new applicants and for follow-up studies. Over a five-year period, we estimate processing a total of 54 patients.

Subjects: A "chronic" TBD is defined as an individual who is at least 12 months post injury and who has been shown to be stable in functioning on two baseline examinations which are administered at least three months apart (conducted at least twelve months post TBD). For the purposes of this project stable means that scores on the baseline test sampling the generic domains of cognitive function are within the limits of one standard deviation and the Rehabilitation Indicators (RI's) are stable.

Design: On application to the program a subject (who will have to be at least one year post TBD) receives the psychometric tests, the RI's and the neurologic examinations and is told that he/she will be placed on a waiting list. If the pre-examination three months later reveals the person is stable, he/she is eligible to enter the program as soon as an opening is made available. If the person is not found stable, he/she is told to wait another three months and then return for re-examination. These tests are repeated at the end of each treatment cycle and at the end of the one-year follow-up period.

Procedure: Following assessment, the patient's requirements in terms of remedial interventions in four domains of perceptual-cognitive functions is determined. These modules are as follows:

- a. Orientation, i.e., systematic training in attention/concentration.
- b. Visual information processing.
- c. Eye-hand coordination with dexterity and constructional skills.
- d. Verbal abstraction.

Remedial interventions are also given in the area of social roles and in a sampling of pre-vocational skills related to module c (eye-hand coordination).

The orientation module will be administered to all patients first so that "overlay" phenomena can be eliminated before commencing any other type of systematic cognitive training.

FINDINGS TO DATE: Various assessment measures under the following categories were shown:

- a. Psychomotor tests of vigilance, persistence and concentration
- b. Tests of dexterity and functional (tool use) samples
- c. Tests of visual perception and perceptual motor integration
- d. Measures of cognitive perceptual integration and memory
- e. Measures of memory and basic academic skills
- f. Measures of general and specific intellectual aptitude
- g. Measures of reasoning, self-knowledge, openness and social skills
- h. Prevocational module

Preliminary data has been collected. Analysis will not be available until a later date.

APPLICABILITY: Patients with traumatic brain damage who enter medical rehabilitation settings generally exhibit disturbances in motor and/or speech functions and cognitive and perceptual defects which interfere with normal functioning. They generally require long-term attention in a variety of therapies. These therapies have to deal with the layering effects of these multiple problems and their generic relationships to vocational outcomes. While physical and ADL restoration can often be attained, the relationship between these gains and a vocational outcome is severely attenuated unless the cognitive and perceptual deficits are treated as well. Our work with hemiparetics due to cerebral vascular accidents (CVA) suggested that our way of approaching diagnosis and remediation would also be of value for traumatic brain injury cases. During the past several years, we have had the opportunity to apply to this population some of the skills acquired in managing, diagnosing and treating stroke victims.

014 Muscle Re-Education in the Hemiparetic Patient by Use of EMG Feedback

Principal Investigator:	Arthur Eberstein, Ph.D.	
Status:	Continuing	
Dates:	September 1977-September 1980	
Cost:	Annual \$113,249 RT Annual \$101,485	Projected Total \$300,000 RT % of Annual total 90%
Annual Report Reference:	#18, Page 326, R-94	

Objectives: **General Hypothesis:** Functional recovery in the hemiplegic upper extremity will be facilitated by providing the patient with audiovisual feedback derived from EMG activity transduced by means of surface electrodes and integrated over 100 msec intervals. Active range of motion and functional performance will correlate positively with EMG performance.

Secondary Hypothesis A: The employment of video display consisting of two simultaneously presented EMG channels, each of which represents one member of an agonist-antagonist pair,

will be particularly effective as a source of feedback in training the reduction of spasticity.

Secondary Hypothesis B: A flaccid member of an agonist-antagonist pair can be selectively trained through the employment of a variable threshold level, displayed as a horizontal line on the video screen, coupled with an audio signal whose presence is made contingent upon the patient's production of an EMG level greater than or equal to the threshold level.

METHODOLOGY: Validity: Computation and recording of EMG activity was accomplished by means of a Functional Biosystems bioconditioner (Model 6801). It is an established fact that EMG integrated over brief time intervals is a valid index of muscular activity occurring during the execution of movement patterns. Validity was further assured by observing the actual movement performed by the patient during daily acquisition of integrated EMG response for each muscle, in addition to the initial and physical assessments employing traditional physical and occupational therapy procedures.

Reliability of measurement was insured by employing the following procedure: (1) Location of optimal electrode placement sites was achieved by reference to anatomical landmarks and motor point location by means of electrical stimulation. Electrode placement was finally established by measuring distance and resistance between each member of an electrode pair with reference to the indifferent electrode. (2) Where necessary the skin surface of the affected extremity was shaved. (3) The starting position of the involved extremity was kept the same both between and within sessions, during daily acquisition of measurement. (4) Simultaneously recording an integrated EMG response for each muscle and its antagonist during an attempted movement on at least six occasions per session. The six data points were obtained over two sweeps during which time the patient was instructed to perform three responses per sweep. The EMG performance for each of these sweeps was stored in memory, and displayed on the video screen during which time they were photographed. The six data points obtained from each muscle activity were averaged and a single daily representative value calculated.

FINDINGS TO DATE: Eighteen hemiplegic patients, 5 in the acute and 13 in the chronic phase of hemiplegia participated. All acute patients were undergoing physical and occupational therapy during the time they were in the study, although none for the affected upper extremity. Five chronic patients were receiving traditional therapeutic exercise but only one for the affected upper extremities. The remainder had undergone traditional therapies and had reached an apparent limit of progress in upper extremity function.

All patients without exception gained in their ability to produce and modulate EMG activity in the hemiparetic upper extremity. Of the various target muscle groups the biceps-triceps combination, whether trained to perform elbow flexion or elbow extension, yielded the most impressive and reliable effects. These gains were reflected not only in improved EMG response but in noticeable improvements in active range of motion. The latter fact has prompted us to incorporate the measurement of AROM's as an integral part of our evaluative techniques (see below). During shoulder flexion all patients were able to reduce the synergistic pattern of elevated EMG activity of the upper trapezius relative to the anterior deltoid, and to increase their active range of motion on this task.

With regard to functional gains, as gauged by the performance of activities of daily living (ADL) finger extension proved critical. Patients who had not achieved finger extension reported little practical use of their affected upper extremity. Patients who could extend their fingers visibly reported dramatic functional gains - viz, using the extremity to pick up items, to hold utensils, etc.

Overall the results obtained to date have been confirmatory to the general hypothesis posed above as well as to the secondary hypotheses. It is evident that some aspects of our EMG feedback training are responsible for recovery of upper extremity function in the hemiplegic patients who participated in our study. The use of the single-case multiple baseline design, together with the fact that many of the patients studied were chronic hemiplegics who had received traditional therapies and had reached an apparent limit of progress, enables us to be confident that the observed gains were associated with treatment and not with general recovery or other forms of treatment.

APPLICABILITY: This project has immediate relevance to rehabilitation of neuromuscular dysfunction. EMG feedback in this clinical application represents an extra tool in the armamentarium of

rehabilitation techniques applied to hemiparetic patients, improvement of motor function may be obtained in a shorter span of time as compared to conventional procedures.

The goal of this project is the retraining of the patient's own capacities in the most efficient manner possible. Combining the efforts of the therapist with self-generated feedback from the patient promises to provide a substantial increase in the efficiency of the educational process. This should lead to earlier recovery of the patient, thereby saving his/her time and expense as well as time of the therapist.

015 Factors Underlying Improvement in Respiratory Function Following Cervical Cord Injury

Principal Investigator:	Francois Haas, Ph.D.	
Status:	Continuing	
Dates:	August 1976-July 1979	
Cost:	Annual \$85,712 RT Annual \$85,712	Projected Total \$390,000 RT % of Annual Total 100%
Annual Report Reference:	#18, Page 29, R-98	

OBJECTIVES: The object of this study is to quantify the patterns of improvement in several different areas of respiration and to assess the role played by each of several factors which may promote improvement from the onset of a traumatic cervical cord injury until stabilization occurs. These include studies on (1) the effects of loss of sensation from the rib cage on the reflex ability to regulate ventilation (sensory studies), (2) the factors which lead to improvement in respiration throughout the clinical course (motor studies), and (3) the effects of sensory and motor dysfunction on the ability to maintain effective blood gases and acid-base balance (blood gas studies).

METHODOLOGY: In order to accomplish these goals the following tests have to be carried out. These tests are noninvasive and are designed to produce a minimum of discomfort to the patient and start as close to the time of injury (the best time to be at the inception of the rehabilitation program) as possible and continue for a period of 3 years. First at monthly monitoring, and then every three months. A base line pulmonary function test using either the Goddard Twin Bell Spirometer or the CIP Pulmolab will be carried out at the admission of the patient to the study, and then twice yearly. In addition, the following physiological measurements for each of the other areas of investigation are planned:

I. Sensory Studies: The methods used in the sensory studies involve strictly non-invasive techniques. Patients inspire in the supine position through a J-valve and expire into the atmosphere. The inspiratory limb contains a pneumotachograph to record air flow and a pressure transducer to monitor mouth pressure. Tidal volume is obtained by electronic integration of the flow signal. Samples of expired air are delivered to a capnograph to monitor end-tidal CO₂.

Each patient's respiratory resistance and elastance are measured. The anticipated tidal volumes under load conditions are computed from a first order linear differential equation assuming a sinusoidal inspiratory pressure waveform. Deviations between observed and calculated values of tidal volume are used to deduce reflex or mechanical alterations in inspiratory pressure during the loaded breath.

The experimental groups studies thus far have been chosen to include a range of lesion levels (from T-3 to C-4) and ages (13 to 40) to determine the effect of lesion level and age on respiratory performance.

II. Motor Studies: The methodology of this part of the project requires noninvasive measurements obtained at bedside. The measurements include (1) vital capacity and its subdivisions from a spirometer, (2) rib cage stabilization from chest pneumograms during different breathing maneuvers, (3) respiratory compliance from a weighted spirometer bell to produce a change in lung volume at FRC, (4) peak inspiratory pressure against a closed shutter to determine the isometric pressure generated by the diaphragm, and (5) neurological improvement obtained from physical examination.

Each new patient has these measurements made once monthly and an attempt will be made to correlate these results with age, sex, and level of lesion.

III. Blood Gas Studies:

- (1) For the blood gas and acid base balance, the Astrup Micro method will be used as described by Segal and Anderson. The capillary blood was chosen to avoid the use of arterial puncture, and possible complications (this test is as accurate as arterial). This test should be given monthly in the early stages and every three months in the latter stages.
- (2) Chest stability, sighing and respiratory compliance data will be obtained from measurements in Motor Studies. (See above Motor Study Methods 2 and 3).

FINDINGS TO DATE:

I. Sensory Studies: We have completed the quantification of the first-breath ventilatory response to a range of both elastic and resistive (inspiration through a narrow tube to stimulate a sudden increase in airway resistance) loads in a group of 80 naive normal subjects (i.e., unfamiliar with respiratory experimentation). As stated in our previous progress report, this new study stemmed from our finding that some of the naive normal subjects in our initial study produced VT responses against elastic load which differed markedly from previously published responses that were apparently obtained in experienced subjects. We therefore set out to establish a realistic set of standards which could be used to analyze loaded breathing responses in our cord-injured population. The results of this study indicated that previously published "normal" responses represent only one point in a continuum of possible responses and thereby demonstrates that the application of the existing "normal" standards to patient populations can lead to erroneous conclusions. We derived a new mathematical model which permitted us to predict the mechanical effects of added loads on inspiration. This model, in turn, enabled us to demonstrate that the continuum of ventilatory responses in naive subjects, which could not be explained by mechanical considerations, represented individual variation in inspiratory motoneuron output under load conditions. In contrast to previous studies which emphasize VT-defense against loads, these new findings indicate that other parameters provide better indices of load-compensating mechanisms when variations in inspiratory motoneuron output occur. The results of this study, which is the most comprehensive work on loaded breathing to date appeared in the April 1979 issue of the **Journal of Applied Physiology: Respiration, Environmental and Exercise Physiology**.

We have employed these data from normal subjects to analyze the ventilatory response to graded elastic and resistive loads in a group of 18 cord-injured subjects. The derivation of a new mathematical model has enabled us to demonstrate that rib cage proprioceptors influence the duration and timing of the phrenic motoneuron train but not its average intensity. These findings were presented at the 63rd Annual FASEB Meetings, April 1979 and have been published only in abstract form. This work is currently being prepared for submission to the **Journal of Applied Physiology: Respiration, Environmental and Exercise Physiology**.

II. Motor Studies: A total of 56 cervical cord-injured patients whose level of injury ranged from C3 to T4 had partial respiratory motor tests performed. Analysis of the expiratory flow-volume loop indicated that subjects who were at least 12 month post injury had significantly improved flows and volumes as compared to those less than 12 months post-trauma. This further substantiates the hypothesis that there is significant improvement in pulmonary function over the first 12 months post-trauma. The factors which underly this improvement remain uncertain, consequently we have purchased, and are awaiting delivery of magnetometers with which rib cage stability can be ascertained. In addition we have started our analysis of the inspiratory phase of flow-volume. We are continuing to test patients and have instituted the new protocol outlined above. The data summarized in last year's progress report is presently being prepared for publication.

APPLICABILITY: Results from this study should facilitate:

1. One's ability to plan a more appropriate and realistic vocational rehabilitation program, because of increased accuracy of knowledge of nature and extent of deficit, particularly with respect to potential energy resources;
 2. Less interruption from respiratory problems of an ongoing vocational rehabilitation training program resulting in more efficient use of the program's resources; and
- Reduced hypoxemia providing greater energy resources and mental acuity for the patient.

016 Quantification of Electromyography with Computer Analysis

Principal Investigator: Arthur Ebersole, Ph.D.
Status: Continuing
Dates: October 1978-September 1981
Cost: Annual \$76,184 Projected Total \$190,000
RT Annual \$58,120 RT % of Annual Total 76%
Annual Report Reference: #15, Page 363, R-100

OBJECTIVES: The goal of this study is to differentiate muscle fiber types within electromyography.

The specific objectives are as follows:

1. Record electrical activity from skeletal muscle during weak contraction.
2. With a computer, derive power spectrum for the recorded myoelectric activity.
3. Calculate the action potential conduction velocity for the sampled muscle fibers.
4. Compare conduction velocities of muscle fibers in normal muscle with those obtained in diseased muscle.

METHODOLOGY: The methodology is based on a mathematical model which describes the Fourier transform and power spectrum of single motor unit action potentials. In the model, muscle fibers are described as long cylinders lined up in parallel, and action potentials propagating in both directions from an innervation point. The sum of the action potentials from a group of single fibers contributing to the motor unit potential can be derived for a point in the muscle volume. This potential variation with respect to time can be transformed into a Fourier series. From this, the power spectrum for a single motor unit action potential can be derived. The power spectrum is a function of the (a) temporal dispersion of individual fiber potentials, (b) spatial dispersion of the fibers, and (c) action potential velocity dispersion. The present study is based on the dependency of the power spectrum on the conduction velocity. Thus, knowing the power spectrum we may calculate the conduction velocity.

The experimental procedure utilizes conventional electromyographic (EMG) technique. Standard EMG electrodes and equipment are used throughout the study.

FINDINGS TO DATE: Data was collected and analyzed from 15 normal male subjects, ranging in age from 28-48 years. The procedure in each case involved placing two surface electrodes over the distal portion of the biceps brachii muscle, aligned parallel with the muscle fibers. The electrodes are metal discs, 1 cm in diameter, embedded in a plastic holder so that their separation is fixed at 3 cm. The electrodes were connected to a TECA electromyograph.

Weak volitional contractions permitted single motor unit potentials to be detected and recorded on magnetic tape. The entire procedure of affixing the electrodes and recording approximately 5 sec of data required about 30 min. The potentials were then entered from the tape into the computer (DEC PDP 11/34). Since the frequency response of our recording system was set at 20 to 5,000 Hz, the EMG signals were converted to digital form with a sampling rate of 10,000 Hz by means of an A/D converter. A fast Fourier transform was performed by the computer on 1024 points.

A Fourier transform and power spectrum was computed for each recorded potential. For each subject, the average of 10 power spectra was calculated and plotted. It is seen that the amplitude of the power is relatively constant up to about 90 Hz and then drops precipitously. The spectral minima are clearly visible. The first spectral minima ($n=1$) occurs at approximately 150 Hz. Since d is 3 cm, n is 1, f is 150 Hz, then for this subject the muscle conduction velocity ($v=df/n$) is calculated to be 4.5 m/sec. In this manner we calculated the muscle conduction velocity for each subject. The velocity ranged from 3.3 to 4.5 m/sec., with an average of 4.3 ± 0.4 m/sec.

The close agreement in velocity between subjects is very encouraging in terms of the procedure we used and the analysis of the data. We now plan to collect data from patients with various forms of myopathy as well as continue to accumulate data from normal subjects.

APPLICABILITY: Neuromuscular diseases are among the leading causes of severe chronic disability in children and adults. Previously well-defined classifications of these diseases into neuropathies and myopathies are now subject to question and considerable alteration. This creates problems associated with the diagnosis of an ailment which in turn become problems on rehabilitation since an incomplete or incorrect assessment of the disorder results in inadequate and less successful rehabilitation of the patient to independent functioning. This study is relevant to the goals of rehabilitation as defined in Section 202 (a) of the 1973 Vocational Rehabilitation Act. The Act specifically mentions that projects supported under this section "may include medical and other scientific, technical, methodological, and other investigations into the nature of disability, methods of analyzing it, and restorative techniques; ... and relative activities which hold promise of increasing knowledge and improving methods in the rehabilitation of handicapped individuals and individuals with most handicaps."

Due to the complicated nature of classification of neuromuscular disease through electromyography, we have elected to computerize correlations between electrical activity and specific muscle and nerve pathophysiology. With increased sophistication that is inherent in such a system physicians will be able to diagnose neuromuscular pathology in a much more rational manner, with greater rapidity.

017 Evaluation of Electronic Self-Help Devices for Severely Disabled Patients

Principal Investigator:	Heiner Sell, M.D.	
Status:	Continuing	
Dates:	October 1977-September 1982	
Cost:	Annual \$116,066 RT Annual \$96,985	Projected Total \$700,000 RT % of Annual Total 84%
Annual Report Reference:	#18, Page 695, R-101	

OBJECTIVES: The objective of this project is to accomplish comprehensive multi-disciplinary evaluation of electronic assistive devices and potential device users in order to:

1. Determine the usefulness of such equipment in the rehabilitation of the severely disabled individuals.
2. Identify factors which prevent full utilization of such equipment.
3. Encourage incorporation of current findings into device improvement or original development in order to facilitate full utilization and therefore increased independence of the severely disabled.
4. Develop equipment when commercial efforts do not address identified functional needs.
5. Determine the impact of utilization of electronic assistive devices on the life style of severely disabled persons.
6. To assess the factors influencing the actual purchase of electronic assistive devices and determine the cost-benefit of such expenditures.

METHODOLOGY: The objectives of this project have been pursued via:

- I. Clinical Evaluation.
- II. Developmental Efforts.
- III. Psychological Testing.

A consumer advisory board has been maintained. Members include disabled IRM staff members and former patients, each group of which has participated in the actual evaluation of specific devices, as well as former IRM patients who have not participated in any evaluations. The purpose of liaison with board members is to provide validation for continuation of warranted project directions and abandonment of others.

Coordinated efforts for cooperative work has been initiated with other IRM and non-IRM research which is addressing similar needs of the severely disabled.

Areas of testing:

- a. Environmental Control Systems
- b. Mobility Control Systems
- c. Dictaphones and Tape Recorder Controls
- d. Page Turners
- e. Door Operators
- f. Communication Aids
- g. Typewriter Control Systems

FINDINGS TO DATE: For the highest level of comprehension regarding project results, a monograph is currently available through our Publications Office. For abstracts of the results, please consult Annual Report 16-P-56801/2-18.

APPLICABILITY: By determining the usefulness of electronic assistive devices within the rehabilitation of severely disabled persons, this study will permit the selection of cost-effective devices which can offer individuals improved life styles and/or increased vocational opportunities. For specific patients use of such equipment can reduce attendant care costs and thereby lower the dollar cost of overall medical care. By identification of factors which prevent full utilization of such equipment and, in turn, either working with manufacturers to facilitate device re-design or initiating original design, this project provides an opportunity for incorporation of evaluation findings into product improvement.

018 Communication Disorders in Adults with Traumatic Brain Damage

Principal Investigator:	Martha T. Sarno, M.A.	
Status:	Continuing	
Dates:	October 1977-September 1980	
Cost:	Annual \$30,473 RT Annual \$26,854	Projected Total \$88,000 RT % of Annual Total 88%
Annual Report Reference:	#18, Page 145, R-102	

OBJECTIVES:

1. To determine the characteristics of language, cognitive and perceptual-motor impairments due to traumatic head injuries, exclusive of those incurred by gunshot wounds.
2. To correlate those impairments with the ability or inability to function socially and vocationally.
3. To determine the degree and course of recovery of such impairments.
4. To establish correlations between degree of recovery and age, length of coma, locus of pathology, time post-trauma and severity.
5. To identify those deficits which lend themselves to treatment or amelioration through the application of rehabilitation techniques, the end purpose of which is improved psychologic, social and vocational potential.

Hypothesis to be Tested: The language, cognitive and perceptual impairments secondary to brain damage resulting from closed head injuries differ in nature, characteristics, degree, and course of recovery from impairments secondary to brain damage resulting from other etiologies.

METHODOLOGY: In this study, the term **anatomical discontinuity** refers to injuries in which there was documented evidence of infarction or laceration of cerebral tissue. This includes any trauma (except missile wounds) which resulted in tearing, loss or compression of brain tissue.

The designation **aphasia** was limited to patients who manifested specific deficits in the pro-

cessing of information via the speech code, that is, patients whose use of speech for expression and/or reception was impaired. This definition, then, excluded patients with reading deficits who did not also exhibit some of the classical speech symptoms of aphasia (i.e., paraphasic errors, word finding difficulty).

Types of aphasia were designated according to the classification of Geschwind (7) and Benson (1). It should be noted that the designation of aphasia was made exclusively on the basis of clinical observations and in a few instances there was disagreement among speech pathology staff members as to whether a patient was indeed aphasic. **Dysarthria** was defined as a speech deficit on the basis of pathology of the motor speech system evident in defects of the acoustic aspects of the speech stream (i.e., articulation, resonance, stress and intonation). The term **sub-clinical aphasic disorder** was used to refer to evidence of linguistic processing deficits on testing in the absence of clinical manifestations of linguistic impairment. The notion of the existence of linguistic deficits secondary to brain damage which do not resemble the classical aphasic syndromes but which are not associated with a state of dementia is not new to the aphasia literature. Bolter and Vignolo (3) referred to "latent aphasia" and Geschwind (5, 6) addressed himself to the characterization of a variety of non-aphasic naming defects.

Subtests of the Neurosensory Center Comprehensive Examination for Aphasia were administered. Four subtests were used as a database: visual naming; word fluency; sentence repetition; and the token test.

The patients had been referred to the Speech Pathology Service at various points in the post-traumatic period ranging from three weeks to eight years. Time since onset (TSO) at first test for the whole group was 48 weeks (mean time), and 27.5 weeks (median). Whenever possible, testing was administered at three months post-injury and thereafter at six month intervals.

FINDINGS TO DATE: Fifty-six closed head injured patients (CHI) referred for speech pathology services were examined to determine the presence and nature of verbal deficits. Eighteen (32%) presented classical symptoms of aphasia, 21 (38%) had motor dysarthria, and 17 (30%) had no discernible aphasic deficits in spontaneous speech but showed clear evidence of verbal deficit on testing.

No patient admitted with sequelae of CHI was spared some degree of verbal impairment, however mild or apparent. Furthermore, dysarthric patients without exception, showed sub-clinical linguistic deficits. Though the patients studied were thought to be more severe than most of those reported in the literature, our findings suggest the desirability of a careful linguistic evaluation of all CHI patients because of the potential impact of verbal deficits on rehabilitation outcome.

The data are being analyzed to determine the nature, characteristics, degree, and course of recovery from impairments secondary to brain damage. Correlations will be established between degree of recovery and age, length of coma, locus of pathology, time post trauma, and severity. These impairments will also be correlated with the inability to function socially and vocationally.

APPLICABILITY: The patient with brain damage of any kind represents a challenge to rehabilitation because of the complexity and severity of the pathology. The group being studied here, by virtue of the mode of injury, presents problems which appear to differ from those manifest in patients with brain damage on the basis of vascular infarcts or gunshot wounds. Specifically, in some patients there appear to be subtle deficits of verbal behavior which can interfere with vocational or educational performance, in spite of the fact that language may be adequate for every day social purposes.

In order to improve the social and vocational potential of the population under study, it becomes a matter of importance to identify the nature and extent of deficits in higher brain functions, with particular attention to verbal behavior. The findings should help provide guidelines for the physiatrist in making rehabilitation management decisions and for all rehabilitation team members in their direct therapeutic efforts on behalf of these patients (i.e., prevocational exploration).

The ability to use all of the modalities of language adequately is essential to the majority of vocational pursuits, hence the importance of this study.

019 Aphasic Homemaker: Factors Which Influence Independent Meal Preparation

Principal Investigator:	Martha T. Sarno, M.A.	
Status:	Continuing	
Dates:	October 1977-September 1980	
Cost:	Annual \$30,651 RT Annual \$23,522	Projected Total \$80,000 RT % of Annual Total 77%
Annual Report Reference:	#18, Page 156, R-103	

OBJECTIVES: The proposed protocols intend to:

1. Identify and examine the demographic, linguistic, cognitive and perceptual factors which contribute to the aphasic female's successful return to a homemaker role.
2. Examine the functional carryover of successful returnees by an at-home follow-up observation two years or more after the onset of disability.
3. Develop a practical, easy to administer, rating scale for use by rehabilitation workers following simple guidelines which measures functional homemaking adequacy.

METHODOLOGY: The patients will be post-stroke aphasic females who had strokes more than two years prior to their selection for study. Those selected will be right handed, native speakers of English who were known to be literate prior to the stroke. All of the patients will have vascular lesions of the left hemisphere, which, in the majority of cases, had been established by neuroradiologic studies. They will all have normal hearing thresholds (30 db) across the speech frequencies. The importance of controlling for these variables has been well established in the literature on aphasia (Darley 1972, Vignolo 1964, Sarno 1972, Sarno 1975).

Those patients selected for study will be contacted by telephone and mail and invited to return to IRM for a series of tests which will total about six hours spanning a couple of days. Patients will be contacted for testing sometime after two years have lapsed since the onset of disability since it appears that stroke patients are vocationally stable at about that time (Weisbroth et al., 1971). At about the same time the home economist/occupational therapist will arrange a home visit for follow-up homemaking observation ratings.

Tests will be administered in the areas of language, cognition, perception, and homemaking. With the exception of the homemaking measure all of the tests are in current use in the IRM Speech Pathology Service. The measures are:

1. The **Functional Communication Profile** (FCP) (Taylor 1965).
2. The **Neurosensory Center Comprehensive Examination for Aphasia** (NCCEA) (Spreen, Benton 1969).
Subtests: Visual Naming; Description of Use; Work Fluency; Sentence Repetition; Sentence Construction; Object Identification; and Token Test.
3. The **Boston Aphasia Diagnostic Examination** (BDAE) (Goodglass, Kaplan 1972).
Subtests: Non-Verbal Agility; Complex Ideational Material; The **Parietal Lobe Battery** (PLB).
4. The **Functional Life Scale** (FLS) (Sarno et al., 1973).
5. **Functional Homemaking Scale** (to be designed).

FINDINGS TO DATE: The **Functional Homemaker Scale (FHS)** has been designed to assess the functional homemaking adequacy of aphasic patients. Test-retest reliability is currently being established. Fifteen patients' ratings will comprise the reliability data base. The FHS will be the independent variable against which all other test results will be correlated at the termination of the study. The scale is being administered by the Homemaker-OT during the home visit.

Since the study concerns itself with the type and severity of impairment in linguistic, cognitive, perceptual and physical areas to ultimate ability to function in a homemaker role, patients are selected for study only after they have completed the physical rehabilitation process. They may

or may not have participated in a homemaker training regimen during the dynamic phase of their rehabilitation course. It is not within the scope of this study to examine the relationship of training or length of rehabilitation exposure to potential role as homemaker.

APPLICABILITY: Since state vocational rehabilitation agencies fund rehabilitation services for homemakers on the basis that homemaking is a vocation, there is a great need for information concerning the characteristics and potential functional adequacy of the aphasic homemaker. The rehabilitation counselor is in particular need of this information as part of his counseling skills. This is the only vocational category which is non-competitive and seems, therefore, a logical area of exploration.

020 Center for Specification and Evaluation of Functional Performance of Services and Instruments for the Severely Disabled

Principal Investigator:	Myron Youdin, MEE	
Status:	Continuing	
Dates:	October 1977-September 1982	
Cost:	Annual \$164,123 RT Annual \$155,402	Projected Total Not Specified RT % of Annual Total 95%
Annual Report Reference:	#18, Page 715, R-105	

OBJECTIVES: Rehabilitation of patients with neuromuscular skeletal disability is often impeded by the general unavailability of instruments and devices to help them attain maximum self-sufficiency and productivity. Manufacturers are fearful of what they consider a limited market. Furthermore, they are discouraged because the minimum functional performance requirements for most devices have not been agreed upon by the health care deliverers who prescribe them. Acceptability of a product and sales are therefore uncertain particularly when more than one approach is proposed for a similar need.

To help solve this dilemma, the NYU-IRM Rehabilitation Engineering Center will formulate functional performance specifications for instruments and devices for patients with severe neuromuscular skeletal injury, develop engineering test specifications for evaluating and demonstrating compliance with the functional performance specifications, and prepare a catalog which will include instrument description, functional performance specifications, results of engineering evaluation and an approximate cost.

METHODOLOGY:

1. The developer or manufacturer will be asked to supply the following information:
 - a. a technical description of the device. This should include photographs and/or engineering drawings, input power requirements, and description of the principle of operation. For the Environmental Control system the description of operation should include the number and type of channels, voltage and current rating of each channel, and switching mode for each channel, i.e., direct, timed, momentary latching or other.
 - b. description of the type of disability for which the device is intended.
 - c. description of clinical trials that may have been performed.
 - d. description of auxiliary devices required for utilization of the instrument. For the powered wheelchair component of the system we would like to know about the number and type of batteries; for the Environmental Control Unit we would want information on the type of peripherals, i.e., telephone, television monitor, etc.
 - e. description of modifications recommended by the developer himself prior to IRM-FPSEC review.
 - f. price and/or cost information. If device is (or will be) commercially available, selling price should be supplied. If the device is a laboratory prototype, an estimate of cost of parts and labor or anticipated selling price—whichever is appropriate.

g. provisions for service, if this question is appropriate.

h. availability of prototypes or samples for evaluation.

The aforementioned questions are of a general nature about a single device. They will be supplemented by specific questions (in the form of a questionnaire) of a technologic and clinical nature germane to a particular device or instrument.

The formulation of questionnaires will be an on-going process based on experience. The completed questionnaire will be reviewed by a multidisciplinary team consisting of a physiatrist, occupational therapist, biomedical engineer, psychologist, and consumer who has the disability for which the instrumentation is intended. If the referral is from a government agency or commercial manufacturer the questionnaire will be used to determine whether preliminary testing can be performed more expeditiously by the sponsor prior to shipping of the prototype to FPSEC. The questionnaire will also be used to determine whether the device merits the effort of further evaluation.

The second step in formulating functional requirements and test specifications will be a detailed analysis of performance requirements of the instrument by the interdisciplinary team.

FINDINGS TO DATE: Complete summaries of the following areas are available in Annual Report 16-P-56801/2-18 with regards to the following topics:

1. Specifications of Instruments for the Severely Disabled.
2. Environmental Test Laboratory
3. Progress of Environmental Test Program
4. Independent Living Laboratory (Electronic Assistive Devices)
5. Evaluation of Knee Angle Monitor Developed at the Krusen Research Center of the Moss Rehabilitation Hospital
6. Contract with Manufacturers.

APPLICABILITY: Inasmuch as our research product will consist of information about devices, it will serve as a guide for manufacturers and act as a stimulus for entering a clearly defined increasing market. As has been previously pointed out, one of the principal deterrents to manufacturers' wide interest in producing devices for the disabled has been the unavailability of a guide and consensus as to what to produce.

Rehabilitation agencies also will be aided in their selection and prescription of devices and instruments. The consequence—hopefully—will be less confusion and greater pooling of resources to bring more and better devices to the market place. A similar evolutionary process was experienced in the radiation instrument development programs of the Dept. of Defense, Environmental Research and Development Agency, and the Federal Civil Defense Administration. Our research product will provide the legislative and executive branches of the government with factual information that will be helpful in evolving policies and legislation to promote an abundant supply of high quality, effective devices and instruments for the disabled at reasonable cost.

021 Improved Orthotic Design and Biofeedback in Scoliosis Management

Principal Investigator:	H.R. Lehnets, Ph.D.	
Status:	New	
Dates:	May 1979-May 1984	
Cost:	Annual \$38,468 RT Annual \$28,043	Projected Total \$384,000 RT % of Annual Total 73%
Annual Report Reference:	#18, Page 121, R-107	

OBJECTIVES

General Objectives:

1. To design, fabricate, and fit a variation of the presently used Milwaukee brace to improve cosmesis, allow for easier donning of the orthosis by the patient, and improve the effectiveness of the orthosis, especially, in controlling lumbar curvatures.
2. To design, fabricate, and fit a prototype of a biofeedback system for scoliosis management.

Specific Objectives:

1. Redesign of Milwaukee brace
 - a. To design, fabricate, and fit an orthosis with an anterior opening to facilitate donning by the patient.
 - b. To investigate more extensive use of plastics to improve cosmesis, decrease weight, lessen interference with clothing, and diminish bulkiness of the upright projections.
 - c. To fit patients with the orthosis through the already existing evaluation and management system used by the scoliosis clinic at IRM.
 - d. To establish methods of ascertaining patient response to design changes through written questionnaires, observations, and interviews.
 - e. To compare patient response to the redesigned orthosis and traditional orthotic design, in regard to cosmesis and self management.
 - f. To investigate the feasibility of an underarm, unitized orthosis for the treatment of kyphosis and scoliosis.
2. Biofeedback System
 - a. To select a patient currently in treatment, who is willing to act as a model during the development of the system.
 - b. To investigate what designs and materials are most appropriate for construction of the system.
 - c. To investigate which feedback modality, an audio signal or noxious stimulus, and what feedback schedule, are most feasible, effective, and tolerable to the patient.
 - d. To compose diagnostic criteria for future therapeutic application of the system.

METHODOLOGY: Orthotic management of scoliotic deformities has changed little in the last 25 years. There remains a great need to innovate in this area and make orthotic treatment more palatable to the typical adolescent scoliosis patient who is particularly anxious to remain active and has new-found concern over his/her appearance to others. Reducing the psychological trauma that these patients seem to experience while undergoing orthotic treatment through improved cosmesis and comfort, and easier donning is, therefore, of great importance. Being able to discard an orthosis in favor of a considerably less restrictive biofeedback system would go even further toward that end.

These approaches will be accomplished through improved orthotic design, and the use of modular components in redesigning the conventional scoliosis orthosis, and the development of a prototype biofeedback-orthosis system for the scoliotic patient.

Improvement in conservative scoliosis management will further diminish the adverse psychological and physical effects of this progressive deformity. A wider range of remedial treatment will become available for the typical patient at a pre-vocational age and free them to pursue a normal and productive life.

FINDINGS TO DATE: A scoliosis orthosis with an anteriorly opening pelvic girdle was fitted within the last year. No formal follow-up by the orthotist was needed and the patient is only seen when adjustments are required.

APPLICABILITY: Injection-molded, modular, neck ring components for the chin and occiput may be applied to head support and alignment systems in other rehabilitation and medical patient populations.

The prototype biofeedback instrumentation will be portable and compact and may act as a model for application of biofeedback therapy in other rehabilitation and medical patient populations as well as possible applications in education for developmental disabilities.

022 The Effect of Electrical Stimulation on Denervated Muscle

Principal Investigator:	Arthur Eberstein, Ph.D.	
Status:	New	
Dates:	October 1978-September 1981	
Cost:	Annual \$52,872 RT Annual \$59,108	Projected Total \$180,000 RT % of Annual Total 89%
Annual Report Reference:	#18, Page 371, R-108	

OBJECTIVES: The goal of this project is to determine the effect of electrical treatment on resting membrane potential and passive electrical properties of denervated white mammalian skeletal muscle.

The specific objectives are as follows:

1. Denervate one side of rat.
2. Stimulate, starting four days after surgery, the denervated muscle daily for two weeks.
3. Measure resting potential, action potential and membrane input resistance and compare with similar measurements in denervated unstimulated muscles.
4. Determine if fibrillation potentials are present in denervated stimulated muscles.
5. Record twitch and tetanic responses from denervated stimulated muscles and compare with those from denervated unstimulated muscles.

METHODOLOGY: Fifty male Wistar rats weighing 150-200 gms will be used in this study, 25 will be controls and 25 will be test animals. The right hind limb of each rat will be surgically denervated by excision of a 0.5 cm segment of the sciatic nerve, just proximal to the bifurcation of the tibial and common peroneal nerves. The cut end of the proximal portion of the nerve will be capped with silastic tubing to prevent subsequent re-innervation.

The animals will be divided into two groups, according to the treatment received. One group will have their extensor digitorum longus (EDL) muscle stimulated, starting four days after surgery. The other group will not have their muscles stimulated but will serve as denervated controls. To prevent infection or damage to the denervated muscles, electrodes will not be implanted in the legs of the rats. To stimulate, short monopolar EMG electrodes will be placed subcutaneously at either end of the muscle belly (similar to the procedure followed by Westgaard, R.H. et al., J. Physiol., 280:499, 1978). These will be withdrawn at termination of stimulation. The muscle will be stimulated two times each day for 30 minutes each time with pulses 1 msec in duration, 150 volts in amplitude and at a frequency of 10 Hz.

Measurements of resting potential, action potential and membrane input resistance will be performed in vivo after two to four weeks of treatment. For this phase of the study, the EDL will be exposed and bathed in oil maintained at body temperature. A micropipette electrode, filled with 3M KCl, will be slowly lowered into each muscle fiber and the resting potential, indicated by a rapid change in baseline deflection, will be recorded. The micropipette will serve as a recording and a stimulating electrode. The fibers will be stimulated by passing pulses of current through a 10^6 ohm resistor in series with the recording electrode connected in a bridge circuit. In this way the action potential can be initiated and recorded.

Input resistance is the ratio of the steady state electronic potential to the applied current and will be measured by passing a known current through the microelectrode and recording the change in membrane potential.

The mechanical properties of the muscles will be determined by in vivo recording of isotonic contractions. The animals will be anesthetized with sodium pentobarbital, restrained in the left-lateral position, and the EDL muscle exposed on the right side. The proximal tendon after release will be attached to a displacement transducer. Flexible wires will be embedded directly into the EDL, and the muscle stimulated for 0.5 sec with supra-maximal square-wave pulses of tetanizing frequency (100 Hz). All contractions will be performed with the muscle initially at rest length and under a constant 3 to 5 gm load.

All measurements will be performed similarly in denervated unstimulated and denervated stimulated muscles. The mean and standard deviation for each test will be calculated and the significance of the difference between the means of the treated and control groups will be determined.

FINDINGS TO DATE: Twenty-four male Wistar rats, approximately 200 gms in weight, were denervated on one side. One group of 12 rats had their denervated muscles stimulated for 21 days, twice each day for 10 min each time with pulses of 1 msec in duration and at a frequency of 5 Hz. The stimulus strength was set at a level to produce observable extension of the toes. The second group of 12 rats were not stimulated and served as controls.

Prior to any physiological testing of the two experimental groups of muscles, a histochemical survey was performed. EDL muscles from denervated-stimulated and denervated-nonstimulated animals were removed with a biopsy clamp, the mid-portion of each muscle cross-sectioned and stained for ATP-ase. Measurements of muscle fiber diameters were performed in a light microscope. One hundred Type II muscle fibers were measured in each muscle. The non-stimulated muscles had a greater percentage of smaller diameter fibers than the stimulated ones.

The average fiber diameter and standard deviation was $23.0 \pm 2.0 \mu\text{m}$ for the denervated-stimulated fibers and $21.0 \pm 2.0 \mu\text{m}$ for the denervated-nonstimulated fibers. Applying the standard t-test, the mean difference was significant. Thus, we can say that stimulation prevented some atrophy of the denervated muscles and that our experimental procedure is valid.

The mechanical response of each denervated EDL muscle was measured in vivo by recording their isotonic displacement following direct stimulation. The animals were anesthetized with sodium pentobarbital, restrained in the left-lateral position, and the denervated EDL muscle exposed. The proximal tendon was attached to a displacement transducer and flexible wires embedded directly into the muscle. The muscle was stimulated with either a single supramaximal square wave pulse (1 msec duration) for a twitch response, or at a 100 Hz frequency for 0.5 sec for a tetanus.

No difference was found between the two groups in terms of amplitude of response or rise time. The average amplitude of twitch and tetanus for the denervated-nonstimulated group was 4.5 ± 1.5 and 7.0 ± 2.8 mm, respectively; for the denervated-stimulated group, twitch and tetanus was 4.6 ± 1.6 and 6.6 ± 3.2 mm, respectively.

APPLICABILITY: The findings of this study will be utilized by rehabilitation workers in the treatment of patients with spinal cord injuries or lesions of the peripheral nerves. The results will assist in the formulation of guidelines to determine whether this specific treatment should be instituted and the duration of the treatment. It is anticipated that current procedures utilized in stimulation of denervated muscles will be varied in accordance with our findings to optimize the stimulation parameters.

023 Carrier Detection with Quantitative Electromyography

Principal Investigator:	Arthur Eberstein, Ph.D.
Status:	New
Dates:	October 1979-September 1981
Cost:	No expenditures were incurred during this report period.
Annual Report Reference:	#18, Page 379, R-109

OBJECTIVES: To detect carriers of Duchenne muscular dystrophy.

The specific objectives are as follows:

1. Select true carriers using family history as a guide from the NYU Medical Center Neuromuscular Disease Clinic.
2. Perform an electromyographic examination of the biceps while under fixed load.
3. Compute the ratio of turns to mean amplitude as well as the duration and number of phases of motor unit potentials at ten different sites in the muscle.
4. Determine the serum CPK level.
5. Review and integrate results.

METHODOLOGY: Two groups of female subjects will be tested; one group will consist of approximately 20 normal individuals without any personal or family history of neuromuscular disease and a second group will consist of at least 20 known carriers of Duchenne muscular dystrophy. The first group will serve as controls in the study.

The testing program is based on an automatic analysis of the electromyographic interference pattern originally developed in 1964 and revised and improved in 1975. In this test, electrical activity will be led-off from a concentric needle electrode inserted into one of the elbow flexors (biceps brachii or brachialis muscles) and amplified within a frequency range of 20 to 10,000 Hz. The constant force to be maintained by the subject during the recording session will be 30% of the ascertained maximum force. The subject will be supine with the elbow flexed at 90°.

The electromyographic signal, once detected, is processed digitally by a TECA APA 6 Action Potential Analyzer to provide two pulse trains. One pulse train represents the point of change in phase of the potentials (denoted as "turns"), and the other train of pulses corresponds to every change in potential greater than 100 μ V. This threshold level was selected to avoid counting small random oscillations and noise. Thus, changes in direction of the potentials and the mean amplitude are counted. The pulse trains are separately totalized and normalized by the APA 6 Analyzer to provide an alpha-numeric display and automatic print-out of the number of amplitude counts and turn counts per second.

Each pattern of electrical activity recorded for 0.5 sec. of isometric effort will be characterized as follows: (1) the number of turns; (2) the amplitude of voltage changes; (3) the mean amplitude obtained from the number of counts of amplitude divided by that of turns; (4) the ratio of turns to mean amplitude. These parameters will be determined for each of 10 different sites examined per muscle, and then each parameter averaged for the whole muscle. The 10 sites to be examined in each muscle will be obtained by three insertions in the proximal, middle and distal parts of the muscle and by changing the depth of insertions in steps of at least 5 mm.

Serum creatine phosphokinase (CPK) will also be determined for each subject.

In this way, the interference pattern of each muscle will be defined so that these results as well as the CPK values for the normal subjects can be compared with those for the carriers.

Future investigation will include analysis and detection of probable and possible carriers of Duchenne Muscular Dystrophy.

FINDINGS TO DATE: None to date.

APPLICABILITY: Results of this study may be utilized by rehabilitation professionals concerned with counseling parents and relatives of disabled children due to neuromuscular disease. The study not only attempts to improve current procedures for the detection of carriers but will make workers in the field of rehabilitation aware of laboratory practices that are available other than serum CPK determinations. Unfortunately, it is still a common practice to base the advice and guidance presented to a client on a single CPK estimation. With this study, we are therefore increasing the data base from which a more accurate appraisal can be made, benefitting the mother and the relatives.

024 Evaluation of Functional Ability and Training Efficiency in Chronic Obstructive Pulmonary Disease

Principal Investigator:	Horacio Pineda, M.D.	
Status:	New	
Dates:	October 1978-September 1981	
Cost:	Annual \$66,087 RT Annual \$66,807	Projected Total \$210,000 RT % of Annual Total 100%
Annual Report Reference:	#18, Page 34, R-111	

OBJECTIVES: To identify appropriate objective and subjective criteria for COPD patients that correlates with loads or work stress of sufficient intensity, duration and frequency which could be used to:

1. Develop a standardized diagnostic method of exercise testing for COPD patients, and
2. Develop reconditioning exercise programs specifically designed to increase VO_2 maximum in these patients.

METHODOLOGY: The population will consist of one hundred twenty patients with diagnosed COPD divided into equal groups of severe, moderate, or mild COPD. Classification will be based on reduction of the effort independent flows (e.g., FEF 25-75%, FEV_1/FVC): below 50% of predicted will be classified as severe, 50-60% moderate, 65-85% as mild.

Patients will be recruited from the patient population seen at University and Bellevue hospitals and physician referrals. Each patient will be given a complete initial evaluation comprised of a clinical history and physical (CBS SMA₁₂, EKG, X-ray) complete pulmonary function tests and vocational and psycho-social work-up. Complete aerobic metabolism will be studied (VO_2 , VCO_2 , MET, RQ, Lactic Acid, blood gasses) at basal metabolic level, rest (sitting) and during exercise. Treadmill exercise will be closely monitored by a physician in regard to EKG. Exercise levels will be increased every minute in 50 kpm increments (8.5 watts 100m 102) until a maximum is reached. Heart rate and blood pressure for gas analysis will be drawn. Maximum tolerable exercise (W_{max}) will be limited by any or all of the following standards set by the National Heart Association, EKG changes, patient discomfort, or VO_2 maximum. This test will be repeated with supplemental oxygen to maintain adequate saturation as determined by the blood gasses. During this time the breathing pattern and gait will be analyzed for efficiency by a physical therapist.

Following the initial evaluation three sessions will be devoted to teaching more efficient breathing and ambulation techniques. In addition, endurance will be tested as 60% of the W_{max} . The exercise period will be of 15 days duration, 3 days per week for five weeks. Each group of patients will be divided into matched pairs on the basis of age, degree of pulmonary impairment, and maximum work tolerance. Both groups will rest for 30 minutes prior to exercise, in order to establish a resting baseline. Supplemental oxygen will be administered when needed to maintain adequate saturation, and EKG and heart rate will be monitored during the rest, exercise, and recovery periods. Group A will perform continuous work at levels of 60% W_{max} until a heart rate of 85% of predicted is reached. Group B will also exercise to 85% of predicted heart rate but they will alternate 15 seconds at 40% of W_{max} . At the end of the exercise program, patients will be given the same evaluations as the pre-test.

The cardiopulmonary laboratory presently has all the facilities and equipment required except for a high incidence EKG monitor that can be used during exercise. The data obtained will be analyzed as follows: (1) For the individual patients, a home program of exercise will be devised to maintain or further improve his/her physical fitness; (2) The data for the group will be analyzed statistically (e.g., multiple correlation and canonical analysis) so that a profile may be derived for functional disability assessment and physical reconditioning, and to ascertain target norms for respiratory stress tests.

FINDINGS TO DATE: In view of the delay regarding the acceptance of this program and consequent postponement of purchase of an EKG monitor suitable for exercise monitoring, we have not performed any tests on patients. We have, however, spent the few months since the project was proposed in calibrating our other equipment using health individuals.

APPLICABILITY: The proposed dissemination and utilization plan is a broad one, designed to reach not only physicians and paramedical personnel, but to impact also on the vocational rehabilitation service-delivery system. Such a broad plan is necessary in order to change the knowledge and attitudes of all professionals involved in the rehabilitation of the individuals with chronic obstructive pulmonary disease (COPD).

It is hoped that the results of this project will help:

1. to gain acceptance for an objective and universally acceptable rehabilitation admissions criteria for rehabilitation; and
2. to generate policy changes, based on more accurate evaluation of disability and remaining functional capacity, to reduce inequities in disability benefits.

025 The Effects of Resistive Exercises In Improving Respiratory Function In COPD and Neuromuscular Disease

Principal Investigator:	Albert Harzs, M.D.	
Status:	New	
Dates:	October 1978-September 1980	
Cost:	Annual \$38,523 RT Annual \$38,523	Projected Total \$76,000 RT % of Annual Total 100%
Annual Report Reference:	#18, Page 42, R-112	

OBJECTIVES: To assess the benefits of resistive exercises on respiratory muscle function in Chronic Obstructive Pulmonary Disease, Muscular Dystrophy, Hemiplegia and Quadriplegia.

METHODOLOGY: The inability to meet added oxygen demands during increased work levels resulting from ventilatory muscle fatigue results in a decrease in the efficiency of any rehabilitation program. Results from exercises to increase respiratory muscle endurance predicated on isotonic muscle work have been equivocal. The use of isokinetic (resistive) exercise has not been fully explored as a technique for respiratory muscle readaptation. Consequently we have devised an exercise program for both inspiratory and expiratory muscles based on the principle of isokinetic work to be used in patients with COPD or neuromuscular induced weakened respiratory muscles. The improvement will be assessed in terms of isometric pressure generation, peak airflow and maximum breathing capacities.

Assessment of Respiratory Muscle Fatigue

Respiratory muscle fatigue will be ascertained by analyzing the high to low frequency spectrum from the diaphragm and intercostal muscles EMG. Bipolar surface electrodes will be placed in the 6th and 7th intercostal space to measure the diaphragmatic EMG. Intercostal EMGs will be obtained by electrodes placed in the 2nd and 3rd intercostal space parasternally. The EMGs will be recorded on magnetic tape and frequency analysis performed after removing the EKG artifact. (The EKG introduces low frequencies artifacts into the power spectrum and thus must be removed prior to analysis).

FINDINGS TO DATE: In view of the delay in notification of the status of this project and the consequent delay in obtaining magnetometers, work has not begun on the patient program. However, from continuing pilot work and from reports from other laboratories protocol have been modified to reflect the state of the art thinking.

APPLICABILITY: The proposed dissemination and utilization plan is a broad one, targeted to not only the physicians and paramedical personnel but also the vocational rehabilitation service-delivery system. Such a broad plan is necessary in order to increase the familiarity of all professionals involved in the rehabilitation field with the importance of respiratory rehabilitation.

The results of this study are quite vital insofar as they present a technique for improving work tolerance through increased respiratory muscle endurance.



**University of Minnesota (RT-2)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Neuromuscular

Studies of causes, effects, responses and adaptations related to injury or impairment of function of prolonged duration in the neuromuscular system.

Psychosocial-Vocational

Programs on problems in the psychological, social or vocational areas which relate to ability to adapt or respond to the requirements of normal living.

Cardiac Rehabilitation

Activities which communicate research findings of cardiac, pulmonary and vascular requirements for activities throughout the range of normal performance and especially related to adaptation to the requirements of normal living following pathological changes.

Health Care Delivery

Health needs and the efficacy and efficiency of various health services in relation to rehabilitation.

Education in Rehabilitation

Needs, applications, adaptation and modifications of education related to rehabilitation.

Bionomic Adaptations

Methods for responding to or compensating for losses or impairments of interaction with the environment which increase the capacity for performance of the quality of life of the chronically ill or handicapped patient.

Ergonomics

The quantitative evaluation of muscular force, work, power and energy of man.

Spinal Cord Injury

Problems in rehabilitation and adaptation to living including community integration in patients who have suffered spinal cord injury.

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University of Minnesota

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DISCONTINUED

Self-Concept As a Factor in the Rehabilitation of a Physically Disabled Population

PROPOSED

Comparison of Delta 9-tetrahydrocannabinol and Valium's Effect on Spasticity of the Spinal Cord Injured Patient

The Efficiency of Bicycle Exercise

Energy Cost of Locomotion—Ambulation with Prosthetic or Assistive Devices

Proteus Maze Performance and Impulsivity in Stroke Rehabilitation Patients

Perceptual and Judgement Factors in Rehabilitation of Hemiplegic Patients

A Pilot Study: Training Patient Responsibility in Selected Areas of Self-Care

026 Effective Training in Rehabilitation Medicine in New Medical School Curriculum

Principal Investigator: Frederic J. Kottke, M.D., Ph.D.
Status: Completed
Dates: October 1974-October 1976
Cost: Annual \$ Projected Total \$
 RT Annual \$ RT % of Annual Total
Annual Report Reference: #17, Page 261, R-70

OBJECTIVES:

1. To determine the extent to which exposure to rehabilitation medicine education experiences during medical school develops an understanding of and positive attitudes toward chronic disease and disability and the role of rehabilitation medicine in meeting the needs of the patients, and
2. to identify the impacts of rehabilitation medicine educational experiences that are likely candidates for inclusion in today's medical school curricula.

METHODOLOGY: This study utilized a retrospective research design intended to take advantage of natural experimental situations and events that have occurred in four medical schools, three with Rehabilitation Medicine (RM) training (experimental schools) and one without. A mail survey was conducted on practicing physicians in the United States who had attended these schools to determine the lasting attitudinal and behavioral effects stimulated by RM experiences in medical school.

FINDINGS TO DATE: The mail survey and analysis is complete. Complete and useable responses were received from 1,497 physicians. The degree of exposure to RM during medical school is positively associated with later effective practice behavior in dealing with chronically ill and severely disabled individuals.

APPLICABILITY: Because of the shortage of physiatrists, primary care physicians must become more competent in treating chronic illness and disability. This study is intended to assess the relative effectiveness of those representative combinations of RM educational experiences that are today reasonable candidates for inclusion in changing medical school curricula.

027 Study of Heating of Deep Muscle by Short Wave Diathermy

Principal Investigator: James Thompson, M.D.
Status: Completed
Dates: October 1977-September 1978
Cost: N/A (Completed)
Annual Report Reference: #17, Page 269, R-73

OBJECTIVE: To determine the exact temperatures at two deep muscle depths before and after the application of short wave diathermy from two different models of Burdick short wave diathermy machines.

METHODOLOGY: Paid subjects will receive diathermy treatments using nonconductive catheters within 14 gauge needles inserted into the thighs to depths of 5 cm and 3.5 cm, respectively. After removing the needle, thermistors will be inserted into the catheters to obtain baseline muscle temperature. Baseline skin temperature will also be obtained. Eight subjects will be treated with the Burdick X-85 shortwave diathermy machine and eight with the Burdick D-900 self regulating machine. Deep muscle, skin surface and oral temperatures, and blood pressure, pulse, and room temperature will be monitored at appropriate times. Blood samples will be taken before and after diathermy treatments.

FINDINGS TO DATE: This project has been completed. Data has been collected and is being analyzed. Both machines were similarly effective in depth of heating. An effective reservoir of heat is induced by diathermy. Though within normal levels, the CPK levels fell after heating and the LDH uniformly rose.

APPLICABILITY: The technology for measuring deep muscle temperatures now permits improved monitoring. As short wave diathermy is used for numerous pathologic conditions of the musculoskeletal system, an adequate assessment of the range of heating in deep muscle would be valuable in better understanding the thermal role of diathermy.

028 Study of the Responses of the Urethral Sphincters, Detrusor of the Bladder, and Anal Sphincter by Electromyography and Air Cystometry during Stimulation of the Anus and Rectum in Patients with Spinal Cord Injury

Principal Investigator: Arthur Rodriguez, M.D.
Status: Completed
Dates: October 1977-September 1978
Cost: N/A (Completed)
Annual Report Reference: #17, Page 273, R-76

OBJECTIVES:

1. To study whether EMG and air cystometry can differentiate patients with spinal cord damage who can void without a catheter from those who cannot;
2. to study further the anal and rectal stimuli affecting the external urethral sphincter and detrusor of the bladder; and
3. to study whether the external urethral and rectal sphincters can act independently or whether they always cocontract.

METHODOLOGY: The EMG air cystometry was used to study 24 spinal cord injured patients prior to undergoing the multiple effort trial of voiding. In 12 patients, the needles were placed and once moderate baseline activity was obtained the air flow was stopped and various maneuvers were done to note their effects on the urethral sphincter. In 12 patients the urethral sphincter and detrusor response from rectal stimulation was measured by inflating a balloon catheter in the rectum, light touch to the perianal skin, and anal stretch, using two index fingers.

FINDINGS TO DATE: This project has been completed. Success in trial of voiding correlated well with the presence of a synergic sphincter pattern or a flaccid sphincter and bladder. The bladder sphincter pattern did not correlate with the completeness or level of the lesion. External urethral and anal sphincter activity is closely linked during bladder contraction as well as stimulation of the anus and rectum. The levator ani occasionally shows divergent activity. Stretch of the external anal sphincter causes an initial period of increased striated anal and urethral sphincter activity. Prolonged and forceful stretch may inhibit both sphincters, levator ani, and ongoing bladder contraction. Stretch of the rectum with a balloon produced results similar to anal stretch except bladder facilitation was commonly seen. Rehabilitation maneuvers were always accompanied by an initial increase in striated sphincter and levator activity. Urethral or anal sphincter electromyography is an effective tool for selecting those spinal cord injured patients who have marked urethral sphincter inhibition from anal stretch and may thus benefit from anal stretch with Crede to empty their bladders.

APPLICABILITY: If the EMG cystometry proves to be a valuable technique in selecting those patients who will succeed in removing the indwelling Foley catheter, it will prove to be a useful tool in the management of the neurogenic bladder of spinal cord injured persons. The procedure requires a minimum amount of equipment and is easy to perform.

029 Studies of Urologic Function in Patients Following Spinal Cord Injuries

Principal Investigator: Mary Price, M.D.
Status: Continuing
Dates: October 1963-October 1979
Cost: Annual \$241,682 Projected Total \$890,000
RT Annual \$131,884 RT % of Annual Total 55%
Annual Report Reference: #17, Page 5, R-2

PART I

OBJECTIVES:

1. To study renal function and micturition and their relationship to recurrent bladder infection in patients with spinal cord injury;
2. to test methods for improvement of urinary bladder function and management in patients with spinal cord injury;
3. to record the changes of urinary tract function of paraplegic and quadriplegic patients over a period of time.

METHODOLOGY:

1. Renal function is tested by blood and urine analysis after intravenous injection of insulin and para-amino hippurate.
2. The mechanism of urination is studied by air-cystometry, clinical analysis, and radiographic techniques. In catheter-free patients, the amount of urine remaining in the bladder after voiding is measured.
3. Urine culture results in the patient's history of bladder infections are correlated with the findings of the preceding studies.
4. Prediction of the control of bladder contractility is attempted through the use of the urecholine denervation super-sensitivity tests.
5. Data from testing is available for patient information and major statistical analyses.

FINDINGS TO DATE:

1. Sister Kenny Institute patients have withdrawn from this project because of staffing and transportation difficulties.
2. With the approval of the Federal Drug Administration the Renal Function Laboratory was chosen by Amar-Stone Laboratories to compare the efficiency of the modified form of inulin with the older form of inulin in testing glomerular filtration rate. The two substances compared closely with each other. The FDA has approved the inulin and inulin clearance testing has resumed throughout the United States.
3. Five hundred and thirty-six patients have been tested to date.

APPLICABILITY: Preliminary reviews of systematic, ongoing evaluations of spinal cord injury indicate that urinary tract deterioration is not inevitable and that funds spent in training patients physicians, paramedical personnel, and the families of patients in their proper care will result in the a great saving of funds formerly spent as a result of the treatment of physical and psychological deterioration.

Part II

OBJECTIVE: To determine change of renal function in paraplegic and quadriplegic patients who have required ileac diversion and compare these changes with spinal cord injured patients who have not required ileac diversion.

METHODOLOGY: Studies of renal function as outlined in Part I are carried out immediately before diversion and annually thereafter.

FINDINGS TO DATE: A doctoral thesis is being prepared that will demonstrate that while the mean value of annual rate of change of the total population of our study shows slight improvement of function annually, the mean value for annual rate of change of patients with ileac diversions is somewhat better than the mean value of the entire group. Regression lines showing change of function prior to diversion in comparison with change of function after ileal diversion are being prepared. The doctoral candidate preparing the results was forced to postpone the completion of his work.

APPLICABILITY: The surgical procedure, ileac diversion, is being more frequently performed to avoid kidney deterioration resulting from poor kidney drainage. There is need for objective evidence regarding the efficacy of this procedure.

Part III

Discontinued

Part IV

OBJECTIVE: To compile a comprehensive bibliography of the world literature concerning the urinary tract function of patient with spinal cord injury, emphasizing especially the pathophysiology of the urinary tract, laboratory methods for diagnosis, therapeutic approaches and statistical methods of documentation.

METHODOLOGY: Medline is being used to search major medical indices. Primary reference cards are made for 71 subtopics with cross referencing. These have been catalogued.

FINDINGS TO DATE: As of FY 1977, 11,301 primary references are filed with an additional 8,305 cross references and 11,913 authors listed. Members of the laboratory have read 5,232 of the references. As of FY 1978, 11,879 references are filed, with an additional 9,275 cross references, and 13,875 authors listed. Members of the laboratory have read 7,000 of the references.

APPLICABILITY: Through the bibliography it has been possible to improve research techniques and to apply therapeutic findings to patient treatment.

Part V

OBJECTIVE: To accumulate data for future study of the relationship of immunological processes to urinary tract infection.

METHODOLOGY: Electrophoretic patterns of serum proteins are obtained for each patient receiving a urinary tract evaluation. Antibody coating determinations have been requested with selected urine cultures.

FINDINGS TO DATE: Preliminary reports indicate some abnormality of electrophoretic pattern in more than one fourth of the patient tests. Twelve percent showed decreased total serum protein. In the globulin fraction the greatest number of abnormalities was found in Alpha 2, followed by Gamma, Alpha 1, Beta, in that order. Current efforts are being made to correlate the abnormalities found with evidence of upper-tract infection as indicated by calyceal blunting.

APPLICABILITY: Since urinary tract infections are prevalent in patients with spinal cord injuries, treatment of these infections, aided by the determination of immunological changes in the blood, would significantly aid in the rehabilitation and maintenance of rehabilitation of these patients.

Part VI

OBJECTIVE: To document changes in bladder contractility through the use of the Merrill Gas Cystometer.

METHODOLOGY: The gas cystometer is used to record changes in bladder pressure at weekly or bi-weekly intervals for inpatients and at the same time of return visits by outpatients.

FINDINGS TO DATE: During FY 1977, one hundred forty-two gas cystometograms were made, together with 25 denervation and supersensitivity tests, utilizing Urecholine. The gas cystometrogram was used for education for trial of voiding for 20 patients. During FY 1978, one hundred eighty gas cystometograms were made, together with 18 denervation and supersensitivity tests utilizing Urecholine. The gas cystometrogram was used for education for trial of voiding for 20 patients.

APPLICABILITY: The results of this study will aid in improving patient care through the more accurate assessment of the value of cholinergic and sympathomimetic drugs in augmenting or depressing bladder contractility, through the determination of length of period of spinal shock, through predictions of the success of trials of voiding, and through the correlation of the level of spinal cord injury with the changes of pattern contractility.

Part VII
Discontinued

Part VIII
Discontinued

Part IX
OBJECTIVES:

1. To assess the efficacy of a telescopic double lumen catheter in minimizing contamination of urine obtained for culture from the ileal conduit;
2. to establish a reliable method for obtaining urine cultures from patients with ileac diversions.

METHODOLOGY: Urine is obtained for culture by inserting a double lumen catheter into the ileal conduit and by sterile swab from the stoma.

FINDINGS TO DATE:

1. A telescopic double lumen catheter has been used to obtain urine specimens from 120 patients with ileac diversions. Urine culture from the ileal loops of 45 patients showed no growth; 75 cultures showed growth with from 1 to 5 different species of microorganisms: 37% of positive urine cultures grew more than one organism. Urine cultures from the loops of 44 patients showed no growth, even though the stoma swab from the same patients indicated the presence of up to 7 different species of microorganisms on the area surrounding the opening to the loop.
2. These studies indicate that the double lumen catheter method of obtaining urine culture specimens presents a reliable method of determining ileal loop infection and avoids the possibility of contamination as the catheter is inserted through the stoma.
3. This procedure has been incorporated into routine procedures for evaluating the renal function of patients with ileac diversions.
4. Results indicate that improper care of the ileostomy and appliance is a possible source of infection because bacteria may be introduced into the ileal loop and subsequently to the kidneys from a contaminated stoma or collection bag. An illustrated manual was prepared after observation of patient care, both in and out of the hospital, indicating the need for a more explicit educational program for both patients and attendants.

APPLICABILITY: The use of the double lumen catheterization procedure may provide a method of obtaining urine specimens free from contamination as the catheter is inserted through the stoma.

Part X
OBJECTIVES:

1. To study the sources of urinary tract infections in patients with ileac diversions;
2. to determine the extent of bacterial flora present in the ileal loop at the time of diversion and to establish if this bacterial flora plays a part in subsequent infections;
3. to determine if post diversion infections are related to prediversion urinary tract infections;
4. to determine possible sources of postdiversion reinfections.

METHODOLOGY:

1. Aerobic and anaerobic cultures are made from a section of the ileal wall and both ureters at the time of ileac diversion. Urine cultures are made before the operation and serially following the operation.

2. Antibiotic sensitivity tests are made on all organisms present and organisms are saved for future study.

FINDINGS TO DATE:

1. During FY 1977, ten patients with recurrent urinary tract infections exhibiting no fewer than two organisms isolated by urine culture have been followed since before their diversions.

At the time of diversion cultures were made from sections of the ileum (12 had bacterial growth, 7 did not), the right ureter (11 had bacterial growth, 8 did not), and the left ureter (8 had bacterial growth, 9 had no growth and 2 were lost).

2. There has been no correlation between organisms found in the tissue cultures and those found in the post diversion urine cultures.

Results indicate that improper care of ileostomy and appliance is a possible source of infection.

APPLICABILITY: The incidence of bacteriuria in spinal cord injured patients with ileac diversion has remained high. It is important to evaluate the possible reasons for this high incidence of bacteriuria and to establish procedures of care and medical management that will help eliminate urinary tract infection.

Part XI

OBJECTIVE: To determine the predictable normal annual variation of glomerular filtration rate, renal plasma flow, and tubular excretion of individual patients.

METHODOLOGY: A least-squares regression line is plotted using successive test values following the third evaluation of each patient.

FINDINGS TO DATE: Though the doctoral candidate did not finish his dissertation, findings will be published in an abbreviated form.

APPLICABILITY: This study will provide the first documented data regarding the yearly fluctuations of function. This knowledge will provide physicians with guidelines for assessing the clinical importance of changing rates of glomerular filtration rate, renal plasma flow, and tubular excretion in a given patient.

Part XII

OBJECTIVES:

1. To implement a program of patient instruction and training in the care of the urinary tract and urinary collecting devices, emphasizing the importance of maintaining optimal kidney function from the beginning of acute care of the patient following spinal cord injury;
2. to assess the understanding of the patient regarding urinary tract care prior to his leaving the hospital;
3. to assess the value of this program in preventing urinary tract infections and maintaining renal function by comparing information obtained at periodic follow-up of these patients with data from patients not exposed to this program.

METHODOLOGY:

1. Educational material has been prepared and will be given to each spinal cord injured person after admission to the hospital.
2. The staff will check off, date, and sign each subject after it has been discussed.
3. The patient will be tested before discharge. Any remedial education necessary will be done at that time.
4. An effort will be made to include families and attendants in the educational program.

FINDINGS TO DATE: The materials for this patient education program have been developed.

APPLICABILITY: A patient who had adequate understanding of his urinary tract and the methods of

caring for it will have less medical-hospital expense and morbidity. The patient will benefit financially, socially, and vocationally.

030 Study of Cardiac Work Evaluation and Reconditioning After Myocardial Infarction

Principal Investigator:	William Kubicek, Ph.D.	
Status:	Continuing	
Dates:	September 1972-October 1981	
Cost:	Annual \$210,305 RT Annual \$150,647	Projected Total \$750,000 RT % of Annual Total 72%
Annual Report Reference:	#17, Page 36, R-5	

OBJECTIVES:

1. To study the hemodynamic parameters involved after acute myocardial infarction;
2. to study the response of the damaged heart to exercise and stress testing at mild and moderate energy expenditure in early post-myocardial infarction patients.
3. to investigate correlation of the electrocardiograph changes and the cardiac function as recorded from the impedance cardiograph during exercise stress testing in the early subacute stage, at 21 days, and after 3 months or more; and
4. to determine whether the impedance cardiograph and electrocardiograph monitoring of graded exercise tests can be used to establish the safe level of patient performance and progressively test the patient until he or she has demonstrated adequate physical capacity to leave the hospital.

METHODOLOGY:

1. The Minnesota Impedance Cardiograph and a multilead electrograph are used to monitor patients exercising at various levels of exertion, ranging from mild exercise in the early convalescent phase to moderately strenuous bicycle ergometer or treadmill exercise in the post-discharge period.
2. Calculations from the wave forms are made for stroke volume, cardiac output, and parameters related to cardiac contractility.
3. A laboratory for cardiac and metabolic function has been installed at the University of Minnesota Hospitals. This laboratory provides research capability for complete cardiac and metabolic evaluation. The laboratory has the following list of equipment:
 - a. an automated medical Systems PFA-5 mass spectrometer system for metabolic function analysis,
 - b. a model 304A impedance cardiograph,
 - c. a Quinton-Monark Model QI-870 electrically controlled bicycle ergometer,
 - d. a Quinton model 18-49-CI electronically controlled treadmill,
 - e. a Gould model 2400 three-channel analog recorder for use with mass spectrometer system,
 - f. Gould model 481 eight-channel analog recorder for use with mass spectrometer system,
 - g. Physio-Control series 70DC defibrillator,
 - h. Marquette automatic electrocardiograph model 3300, and
 - i. Decwriter connected via telephone with UCC for the input of data into computer storage and calculations.
4. The impedance cardiograph continues to be compared to other methods of measuring cardiac

function. The mass spectrometer has been calibrated to a degree that exceeds the accuracy needed to measure physiological functions.

APPLICABILITY: Problems directly involving the heart can be studied and the status of the patients more accurately assessed, using the Minnesota Impedance Cardiograph. Another field of use is monitoring the amount of fluid in the chest or lungs, such as in congestive heart failure. The third major use of this system is in peripheral vascular disease. Therefore, any doctor treating these patients would have use for the Impedance Cardiograph. The mass spectrometer system is useful for these patients, especially those with cardiopulmonary diseases.

Part I

Completed

Part II

Completed

Part III

OBJECTIVES:

1. To establish an individualized cardiac rehabilitation program;
2. to determine the usefulness of ZCG and ECG monitoring of graded exercise tests in establishing safe levels of patient performance;
3. to determine whether tested progression results in a shorter stay than the standard program; and
4. to determine whether short term rehabilitation restores the patient to vocational activity as fast as the standard program.

FINDINGS TO DATE: A program was established with the cardiologists, cardiac surgeons, and physiatrists. A manual to explain and reinforce the program after discharge is being prepared. The program suffered a set-back when Dr. Ozel died suddenly of a massive myocardial infarction.

Part IV

OBJECTIVES:

1. To introduce, establish normal limits for, and show the usefulness of a cardiac rehabilitation program based on cardiac oxygen consumption as indicated by the heart rate blood pressure product; and
2. to test convalescing cardiac patients to determine relative cardiac stress of activity using heart rate blood pressure method.

METHODOLOGY: Health subjects and cardiac patients were tested while doing homemaking, occupationally related, recreational, and calisthenic activities. Instantaneous measurements of blood pressure, pulse electrocardiogram, total oxygen consumption, and other ventilatory parameters were taken.

FINDINGS TO DATE:

1. Rate pressure product can be used as an indicator of myocardial oxygen consumption and, therefore, work of the heart.
2. This information will allow physicians to objectively decide when postmyocardial infarction patients can return to work.
3. Calisthenic exercises ordinarily performed in inpatient cardiac rehabilitation programs have variable levels of stress for each individual. The amount of training influences the amount of exertion necessary to perform a calisthenic.

APPLICABILITY: The objective measurements of stress of various activities in cardiac patients may allow patients to return to work earlier, and will give vocational counselors and cardiologists a more definitive means of deciding when a patient may safely resume vocational activities.

Part V

OBJECTIVE: To determine the efficacy of measuring, by a non-invasive method, the mechanical pumping action of the heart in patients undergoing surgery for a coronary bypass, to attach an electric pacemaker to the heart, or undergoing heart valve surgery for either commissurotomy or prosthesis.

METHODOLOGY: Impedance cardiograph studies will be made on patients with electrically paced hearts, undergoing aorta-coronary artery bypass surgery, and heart valve surgery for either commissurotomy or prosthesis. Each patient will be studied pre- and postsurgery and follow-up observations will be made.

FINDINGS TO DATE:

1. Recordings were made of 72 patients with electronic pacemakers. Of these, 43 patients exhibited the dz/dt waveform suitable for computing the various cardiac parameters involved. Data shows that the pre-ejection period is longer in the electrically paced heart than in the normal heart.
2. Of the 61 bypass surgery patients studied, 32 had a presurgery dz/dt waveform suitable for computation of the pre- and postsurgery parameters indicated that the bypass procedure had little if any effect on cardiac function in this group of patients.
3. Thirteen patients with heart valve disease were studied. Approximately 2 years will be required to acquire enough data for statistical analysis.

Part VI

OBJECTIVES:

1. To determine the accuracy of using treadmill grade and speed as a measure of the work level performance of cardiac patients undergoing a progressive exercise stress test;
2. to determine whether the addition of metabolic parameters will improve the sensitivity of the progressive stress test to detect coronary artery disease;
3. to objectively evaluate the work level change of coronary artery bypass surgery patients; and
4. to determine whether metabolic parameters will be useful in determining which patients will benefit most from an exercise rehabilitation program.

METHODOLOGY:

1. The actual work level as determined by the oxygen uptake will be measured and then compared with the value predicted by various tables.
2. The data obtained by the ECG and metabolic parameters will be compared with the results obtained by angiography or other events such as myocardial infarction or death due to heart disease.
3. The work performance of patients pre- and post-coronary artery bypass surgery will be evaluated using the metabolic parameters.
4. The metabolic parameters will be correlated with improvement in work performance that occurs on an outpatient exercise program.

FINDINGS TO DATE:

1. The results of the 100 exercise stress tests performed in which the metabolic parameters were evaluated, suggested that an accurate prediction of a patient's work capabilities cannot be made only from predictions based on the grade and speed of the treadmill at the end of an exercise stress test.
2. $VO_2/\text{beat/kg}$ versus the difference between measured METs and predicted METs was plotted. The pattern of the graph shows the greatest difference between normal persons and cardiac patients for the various parameters studied to date.

APPLICABILITY: If the progressive stress test can more effectively evaluate patients, physicians can advise

patients regarding employment more confidently and can evaluate coronary artery bypass surgery more effectively.

Part VII

OBJECTIVE: To develop a low-cost, small, portable device to monitor the exercise level of patients in the cardiac rehabilitation program.

METHODOLOGY: A device will be developed to monitor the heart rate and emit a signal that will indicate deviations of the heart rate from some present level. A second phase of the development will detect arrhythmias.

FINDINGS TO DATE: Two events occurred that caused the discontinuation of this project. The first was the death of Dr. Ozel. The second was the development of a prototype instrument of similar design by Med General, Inc.

APPLICABILITY: A small, portable, low-cost device that can give audio feedback about the physiological level of exercise seems to be ideal to carry on an exercise program for a cardiac patient.

031 Quantitative and Qualitative Evaluation of Muscular Hypertonia in Patients with Central Nervous System Disease

Principal Investigator: Daniel Halpern, M.D.

Status: Continuing

Dates: August 1964-July 1979

Cost: Annual \$85,229
RT Annual \$75,123

Projected Total \$265,000
RT % of Annual Total 88%

Annual Report Reference: #17, Page 113, R-6

OBJECTIVES:

1. To develop an apparatus and system to objectively evaluate the character of abnormal muscle tone and the alterations of tone accomplished by various procedures; and
2. to analyze abnormal muscle tone and evaluate therapeutic procedures.

METHODOLOGY: The analytic system is based on the current neurological concept that the muscle spindle, a sensory organ within skeletal muscle, responds to two parameters of elongation, the amount of stretch, and the velocity of the movement. Recordings are made of the force applied and electromyographic activity during a standardized series of passive movements imposed at velocities varying from 3° to 150° per second. Analysis of the data yields quantitative information in the form of a numerical value of the related physical parameter. This system also allows quantitative study of central nervous system activity giving rise to dystonic states that are not mediated by the fusimotor system. By carrying out an analytic procedure that specifically identifies the responsiveness of the skeletal muscle to lengthening and to the velocity of length, not only can these two elements be identified and measured, but the influence of other sources of tone may be measured as well.

FINDINGS TO DATE: During the year 1976-1977, the construction, assembly, and testing of electro-hydraulic automated drive apparatus were completed. A total of 351 examinations were carried out in 1977-1978. Since June 1977, 77 patients were examined multiple times. Nineteen patients were examined in connection with stereotactic brain surgery, and 14 in connection with cerebellar stimulation for the treatment of dystonia. Twenty-two patients were examined to evaluate the effectiveness of medication on hypertonia, 6 patients were examined to evaluate the effect of intramuscular neurolysis, 3 patients for reflex analysis, and 2 patients for orthopedic surgery. The patients studied for medication participated in a special double-blind study to evaluate the relative effectiveness of Diazepam and D-tetrahydrocannabinol on spasticity in spinal cord injured patient. Fifteen normal subjects were evaluated for gastroc soleus tone. The results revealed that the structures of the gastroc soleus muscles in normal individuals gives rise to significant measures of static and dynamic tone related to elastic and viscous forces within the muscle.

APPLICABILITY: At the present time many procedures for the treatment of patients with muscular hyper-tonia are being carried out, with little more than subjective judgements as to their validity and continued usefulness. Evaluation of each of these treatment techniques would provide a solid scientific basis for their use, and the objective measures would be worthwhile. Treatment of patients with central nervous system disease would be rendered more effectively, less wastefully, and more economically.

032 Study of the Changes in the Structure, Ultrastructure, Innervation and Enzymes of Skeletal Muscle in Neuromuscular Diseases

Principal Investigator:	Essam Awad, M.D., Ph.D.	
Status:	Continuing	
Dates:	September 1969-October 1979	
Cost:	Annual \$73,914 RT Annual \$59,286	Projected Total \$300,000 RT % of Annual Total 80%
Annual Report Reference:	#17, Page 132, R-8	

OBJECTIVES:

1. To study the histopathologic changes occurring in disabling neuromuscular diseases;
2. to study the electrophysiological changes in the neuromuscular system;
3. to study the changes in enzyme activity in these muscles;
4. to identify the specific cause of muscular weakness in individual patients;
5. to improve diagnostic criteria for the neuromuscular diseases that are seen in rehabilitation;
6. to study the ability of human muscle to regenerate as seen in samples taken from patients since the beginning of the project; and
7. to review all the biopsies and enzyme levels of blood samples collected since the beginning of the project.

METHODOLOGY: Patients are evaluated by history, physical examinations, clinical laboratory tests as indicated, and electromyographic and nerve conduction studies. Histopathology of muscle and terminal nerve endings is studied by performing a motor point biopsy to sample the involved muscle(s) and its nerve. The tissue is then processed for: electron microscopic examination of ultrastructure; vital staining with methylene blue to determine the changes in the branches of the intramuscular nerve and the motor end-plates; PAS staining to demonstrate glycogen; toluidine blue staining to demonstrate acid mucopolysaccharides; hematoxyline and eosin staining to demonstrate the structure of the muscle fibers and their nuclei; trichrome staining to evaluate the connective tissue elements in muscle; chemical microanalysis to determine any abnormal constituents in the tissue; review of the biopsy material; and determine the stage of growth or maturation and changes of the cells.

FINDINGS TO DATE: The serum and muscle enzyme analysis that has been done during the course of this project has been reviewed. A cumulative report will soon be completed summarizing the experience from 1969-1978, showing changes in enzyme levels and LDH isoenzyme patterns and serum and muscle of patients with different neuromuscular disorders are specific to certain categories. In group 1, the dystrophies, these were characterized by an increase in all the serum enzymes. The isoenzymes showed elevation of the IV and V fractions in the serum and reduction of the same fractions in the muscle. Group 2, the collagen diseases, including rheumatoid arthritis, dermatomyositis, polymyositis, systemic lupus erythematosus, and scleroderma was characterized by slight elevation of serum LDH in the acute phase. The isoenzymes showed elevation in the III fraction of LDH and serum. In the third group, the serum enzyme activity was normal. There was elevation in the third fraction of the isoenzymes in central core disease, while the same fraction was normal in upper motor neuron diseases and in neuropathies.

APPLICABILITY: The muscular weakness of many disabled individuals is not clearly understood and needs

to be clarified by this research approach, otherwise their rehabilitation will not be complete. As the cases accumulate, the data is analyzed in terms of populations with specific disabilities and their characteristic findings. After studying enough cases in depth, definite conclusions may be drawn that will enable the practicing physicians to identify and analyze the patient's disability and place the patient in the proper perspective.

033 Training Program for Upper Extremity Activities in Athetoid Patients

Principal Investigator:	Daniel Halpern, M.D.	
Status:	Continuing	
Dates:	September 1965-July 1979	
Cost:	Annual \$76,226 RT Annual \$63,337	Projected Total \$245,000 RT % of Annual Total 83%
Annual Report Reference:	#17, Page 139, R-14	

OBJECTIVES:

1. To develop an experimental design and technology to evaluate therapeutic method used in cerebral palsy that will be specific enough to measure difference between methods;
2. to identify elements of neuromuscular function that are important in the development of manual coordination;
3. to test the effectiveness of specific component procedures presently available to develop improved coordination in upper extremities of athetoid patients;
4. to develop a series of procedures to train manual coordination, based on neurophysiologic concepts of motor learning that have been shown experimentally to have therapeutic validity;
5. to develop, by using quantitative evaluation techniques for motor coordination, a method that identifies the specific limitations, or the level of coordination that represents a maximum level of performance in an athetoid patient.

METHODOLOGY: Adult patients acted as their own controls. The effectiveness of the training methods was tested by comparing rates of learning during a given time period. Evaluation was done by attaching battery powered small lights to the hand, wrist, and arm of the patient. Still photographs were then taken by a camera with the shutter open. The resulting data indicated direction, range, tortuosity, regularity of rate, and speed. Half of the group was scheduled into an EXPERIMENTAL-CONTROL-EXPERIMENTAL training sequence, and the other half into a CONTROL-EXPERIMENTAL-CONTROL sequence. More accurate observations were made in this way. The photographic data was recorded by computer. During this past year, the table that allowed electromechanical digitization of the localization of the coordinates of the projected image was constructed, standardized, calibrated, and made operational.

FINDINGS TO DATE: Control of manual skill improved with both INHIBITION and CONTROL training. Therefore, careful direction of attention with feedback and reinforcement for correct activity are the basic elements of motor learning and provide the basic success that was observed. Experimental conditions and method of data analysis were further examined. Using "best" scores, rather than a mean, and increments of improvement in "best" scores have been productive in increasing validation in selecting the optimum treatment. Using the present system of analysis of motor control, data is being collected on the influence of medications, like Diazepam, L-Dopa, and tetrahydrocannabinol. Results are not complete enough for evaluation.

APPLICABILITY: The public, the medical profession, the rehabilitation therapies, and the education profession are engulfed in a morass of opinions, relating to all systems of therapy for cerebral palsy. A clear definition of valid therapeutic principles would improve the function of handicapped patients, relieve the frustrations of their families, prevent wasteful expenditure, and provide a common realistic body of thought among professionals. The identification of the feedback parameters and sensory avenues for monitoring performance that are most effective for motor learning should be a direct consequence of an extended series of investigations using this procedure.

034 Quantitative Studies of Muscular Strength and Muscular Work

Principal Investigator: Martin Mundale, R.P.T.
Status: Continuing
Dates: August 1963-September 1979
Cost: Annual \$69,787 Projected Total \$230,000
RT Annual \$43,347 RT % of Annual Total 62%
Annual Report Reference: #17, Page 153, R-18

OBJECTIVES

1. To develop standardized testing procedures for the major muscle groups;
2. to establish normal values for age and sex;
3. to make meaningful estimates on how much weakness a patient has relative to an adopted norm;
4. to evaluate the deviation of fatigability and endurance from expected normalcy;
5. to evaluate the muscular function of patients prior to surgery and therapy and to evaluate strength and endurance; and
6. to provide experience for medical students, medical residents, and physical therapy students in quantitative methods employed to evaluate strength and endurance.

METHODOLOGY: Transducers and electronic recording equipment are used to test the strength of various muscle groups. Testing has been standardized for hip flexion, hip extension, knee flexion, knee extension, ankle plantar flexion, elbow extension and hand grip. Development of techniques for testing other muscle groups are still under study.

FINDINGS TO DATE: Patients with dermatomyositis have been followed from one to four years, comparing quantitative muscular strength with clinical evaluation and laboratory measures of systemic inflammation. The following studies are in progress: Procedure for Testing Ankle Plantar Flexion and Norms Established, Procedures for Testing Handgrip Force and Norms Established, Comparison of Grip Strength and Grip Endurance During Isometric Exercise, Kinesiology of Hip Extension, and Voluntary Maximal Torque.

APPLICABILITY: Precise, quantitative techniques for measuring muscular strength during isometric contraction make it possible to localize neurologic deficits and quantitative muscular weakness and to follow the effects of treatment. Repeated measurements of strength are used to monitor the patient's status during treatment which aids in deciding the treatment program.

035 A Followup Study of the Psychological, Social, and Vocational Adjustment of Spinal Cord Injured Adults

Principal Investigator: Gary Athelstan, Ph.D.
Status: Continuing
Dates: January 1973-June 1979
Cost: Annual \$31,753 Projected Total \$125,000
RT Annual \$26,830 RT % of Annual Total 84%
Annual Report Reference: #17, Page 166, R-47

OBJECTIVES

1. To gather and analyze descriptive data pertaining to the psychological, social, and vocational adjustment of spinal cord injured adults;
2. to develop and define categories of rehabilitation outcomes, including non-vocational outcomes, based upon measures of psychological adjustment;

3. to identify factors relating to rehabilitation outcomes, including such variables as the psychological and social characteristics of spinal cord injured persons and the various treatments they receive, with a special effort to identify variables which can be manipulated to increase the frequency of desired outcomes.

METHODOLOGY:

1. A sample of 301 spinal cord injured adults, who have been injured for at least 2 years, has been identified. All available relevant data on these patients were tabulated and analyzed to describe the persons and evaluate their psychosocial and vocational adjustment and medical status.
2. In-depth interviews were conducted with the spinal cord injured patients and members of their families. Specially designed interview schedules and standardized instruments were used to gather detailed information on the experiences of the subjects and the steps involved in the process of social, psychological, and vocational adjustment to disability.
3. Psychosocial outcome measures and their relationship to other characteristics of the spinal cord injured patients were developed and refined.

FINDINGS TO DATE:

1. The initial phases of the project have been completed, with 128 subjects and 66 significant others having been interviewed. The extensive data have been edited, coded, and most analyses finished.
2. The definition of psychological adjustment was broadened to devise a composite measure of productive activities apart from employment in which a severely disabled person might engage.
3. A handbook for rehabilitation counselors has been compiled.
4. A handbook for spinal cord injured patients to assist them in vocational rehabilitation is in production.

APPLICABILITY: Since rehabilitation goals tend to be defined in vocational terms, little attention has been devoted to specifying goals for people who need rehabilitation services but have little or no prospect of vocational rehabilitation, including many severely disabled spinal cord injured patients. Specifically designed psychological and social, as well as vocational objectives will aid in focusing the treatment program for persons with spinal cord injuries. Even for those spinal cord injured persons who are not employable, better personal adjustment may carry economic rewards in terms of increased self-care and lower medical costs.

036 Voluntary Control of Autonomic Processes Using Biofeedback and Reinforcement Procedures

Principal Investigator:	Alan Roberts, Ph.D.	
Status:	Continuing	
Dates:	January 1974-June 1979	
Cost:	Annual \$103,091 RT Annual \$84,786	Projected Total \$110,000 RT % of Annual Total 82%
Annual Report Reference:	#17, Page 173, R-53	

OBJECTIVES: To conduct a series of experiments which will provide answers to some questions concerning the voluntary control of autonomic functions, especially skin temperature, and the applicability of autonomic learning to the clinical treatment of disabling disorders associated with dysfunction in peripheral circulation.

METHODOLOGY: Two autonomic reactivity and control scales are administered to subjects. Selected subjects are given a number of baseline tests of autonomic reactivity and control in the laboratory. Subjects selected from the second group are further trained in controlling the temperature of their fingertips. The data from the individual psychophysiological screening sessions on hand-

warming are analyzed. The physiological measures are subjected to ANOVA comparisons of two groups at a time. The physiological measures are subjected to factor analysis, yielding five factors.

FINDINGS TO DATE: A cursory inspection of the data on the 10 subjects who have completed all 16 training sessions suggests that subjects in the high variability group demonstrated much greater ability to control skin temperature.

In a Double Blind Study of the Effectiveness of Skin Temperature Self-Regulation As a Treatment for Raynaud's Disease, 36 patients were studied. Group 1 was trained to increase finger temperature; group 2 was receiving EMG feedback from the frontalis muscle; and group 3 kept records of symptoms at home. Data is being analyzed and preliminary results indicate that no significant differences among the 3 groups are evident for any of the clinical measures recorded.

In Specific Autonomic Learning in a Partially Paralyzed Human Subject, a 23-year-old, male, paraplegic patient was taught to control the skin temperature in his fingers and toes. This patient had intact sensation in his lower limbs, suggesting that sensation may be an important mediator for the instrumental learning of independent and specific visceral responses. At least one human subject learned to voluntarily control a highly specific autonomic function without mediation from striated muscles below the T12 spinal cord level.

APPLICABILITY: As a treatment technique biofeedback will not totally supersede any of the current management systems. In its broadest sense, however, it is bound to become a significant tool for practitioners dealing with specific problems or with a particular aspect of rehabilitation. Even in those instances in which the patient cannot sustain the learning from clinic into his or her daily life, technologies are now available and will be developed to provide permanent biofeedback aids to patients that they can use outside of the clinic, either to maintain or improve their levels of performance. Perhaps one of the most significant advantages of biofeedback training to the disabled patient is that giving the performance information directly to the patient allows him or her to assume a more active and responsible role in his or her own rehabilitation process.

037 An Investigation of Decubitus Ulcer as a Manifestation of a Psychosocial Problem

Principal Investigator:	Thomas Anderson, M.D.	
Status:	Continuing	
Dates:	September 1975-December 1979	
Cost:	Annual \$5,889 RT Annual \$4,787	Projected Total \$44,500 RT % of Annual Total 81%
Annual Report Reference:	#47, Page 193, R-570	

OBJECTIVES:

1. To develop a measurement of decubitus ulcers that would reflect the impact of their occurrence on the patient.
2. to identify those psychosocial factors associated with the occurrence of pressure sores.
3. to develop a new program for training patients and health care workers in the prevention of decubitus ulcers.

METHODOLOGY: This study has two stages. The first stage attempted to delineate those psychosocial factors that would predispose an individual to the increased probability of skin ulceration. Differences on three psychosocial measures among 141 spinal cord injured, both inpatients and outpatients, were examined along with their history of decubitus ulcers since the onset of their injury. The psychosocial measures used were the Tennessee Self Concept Scale, a self-report measure of the individual's personal satisfaction with his life activities, and a measure of individual responsibility in skin care. Multiple linear regression was used to determine those factors associated with the variance in incidence of decubitus ulcers.

The second stage will utilize the information gathered from stage one to determine the direction, content and methods of a new education program. This program will be directed at health care

workers and patients to decrease decubitus ulcer incidence.

FINDINGS TO DATE

Stage 1

1. Individuals who had lost no days from their major activity in the past 2 years showed significantly higher levels of satisfaction with the activities of life and responsibility in skin care.
2. In individuals who had problems with pressure sores, the extent of the pressure sore problem was related to level of injury, help in skin care, satisfaction with activities of life, responsibility in skin care, and self esteem.

Stage 2

The education program, emphasizing personal responsibility in skin care, is being worked out with the nursing staff.

APPLICABILITY: The isolation of some psychosocial aspects of decubitus ulcer incidence will aid in signaling conditions which could predispose a patient to the development of pressure sores. Physicians, DVR counselors, patients and their families can watch for and use these signals.

The development of new programs for teaching skin care hopefully will lower the incidence of decubitus ulcers and their cost.

038 Bibliography of Psychosocial, Vocational, and Sexual Aspects of Spinal Cord Injury

Principal Investigator:	Gary Athelstan, Ph.D.	
Status:	Continuing	
Dates:	November 1975-January 1981	
Cost:	Annual \$7,513 RT Annual \$6,439	Projected Total \$35,855 RT % of Annual Total 86%
Annual Report Reference:	#17, Page 197, R-58	

OBJECTIVES:

1. To provide a well organized, comprehensive bibliography of all confirmed publications about psychosocial, vocational, and sexual aspects of spinal cord injury;
2. to distribute the bibliography widely, both to justify its development and to facilitate the updating process.

METHODOLOGY: Letters stating the purpose of the project and requesting copies of any locally produced bibliographies and articles were sent to all regional spinal cord injury centers and member physicians of the American Spinal Injury Association. In addition to the letters, a review of RSA supported research and a standard search of the medical and psychosocial literature was done using the MEDLARS and PASAR computer search systems. The citations in relevant publications were checked and all references were verified. By updating the literature searches every year and including a request for further materials along the distributed bibliography an up-to-date bibliography will be continually available.

FINDINGS TO DATE: Approximately 650 copies of the bibliography have been distributed. The Educational Resources Information Center has published a resume and the bibliography is now listed on Medline. A continuing update has produced 41 new confirmed references and 100 references in the process of being checked. The first supplement, containing 77 new references has been issued. One hundred and ninety supplements have been distributed and a second supplement is now being distributed.

APPLICABILITY: The rapid growth of spinal cord injury rehabilitation programs, the conceptualization and expansion of the regional spinal cord injury centers, and the concomitant increase in research and theoretical publications make a centralized integration of the diffuse knowledge essential for providing maximally effective utilization for rehabilitation and further research. In its present state

the literature on psychosocial, vocational, and sexual adjustment to spinal cord injury lacks any integration or organization. The large number of relevant journals and identification of these articles makes a literature review for research difficult, and the individual professional rehabilitation worker cannot even be aware of the current state let alone new developments. The availability of an organized, current bibliography could greatly enhance the service and research applications of this growing body of literature.

039 Behavior Modification: A Problem-Oriented, Learning-Based, Research Strategy for Rehabilitation

Principal Investigator: Jerry Martin, Ph.D.
Status: Continuing
Dates: October 1976-September 1981
Cost: Annual \$19,216
RT Annual \$15,596
Projected Total 75,000
RT % of Annual Total 81%
Annual Report Reference: #17, Page 206, R-62

OBJECTIVES:

1. To demonstrate the applicability of behavior modification procedures to the improvement of motor functioning of medical rehabilitation patients in physical and occupational therapy;
2. to determine whether rehabilitation therapists can learn to generate treatment programs based on a behavior analysis or precision teaching model;
3. to focus upon the adolescent medical rehabilitation population so that program effectiveness may be reflected in vocational outcomes; and
4. to evaluate the long-term effectiveness of behavior modification on severely handicapped medical rehabilitation patients through reassessment in outpatient follow-up clinics.

METHODOLOGY: Severely handicapped adolescents with cerebral palsy, closed head injuries, and spinal cord injuries who are hospitalized for medical rehabilitation will be included in this study. Behavior modification will be applied as an adjunct in the treatment of specific motor functioning problems. Short term effectiveness will be evaluated in outpatient follow-up clinics.

FINDINGS TO DATE: A critical review of the literature has been completed. Staff and students in the Rehabilitation Center are receiving inservice training. Pilot studies continue and followup data has been collected. The use of behavioral procedures in getting compliance with medical and therapeutic regimens is being pursued.

APPLICABILITY: The use of behavior modification in rehabilitation has been limited to a very narrow range of problems. Thus, it is not widely used in comparison to its applications elsewhere. Demonstration of behavior modification effectiveness over a broad spectrum of motor behaviors in the severely handicapped should stimulate other facilities to use these techniques for problems other than management of patient misbehavior.

040 Followup Study of Patients Treated in the Pain Treatment Program, Physical Medicine and Rehabilitation Service, University of Minnesota Hospitals

Principal Investigator: Alan Roberts, Ph.D.
Status: Continuing
Dates: September 1976-June 1979
Cost: Annual \$50,132
RT Annual 33,165
Projected Total \$56,000
RT % of Annual Total 66%
Annual Report Reference: #17, Page 216, R-63

OBJECTIVES:

1. To devise a questionnaire to collect data from all patients evaluated in the pain clinic;
2. to administer the questionnaire and the MMPI to these patients and their spouses 12 months after discharge;
3. to interview these patients regarding their experience with the Pain Clinic and/or Pain Treatment Program;
4. to determine the effectiveness of the Pain Treatment Program;
5. to determine possible improvements in evaluation, selection, and treatment procedures; and
6. to test the hypothesis that patients treated in the Pain Treatment Program will show greater activity, more paid employment or other appropriate work, less drug use, and less use of health care than those rejected or not treated.

METHODOLOGY: A thorough review of the current literature on pain research will be conducted and the research will be coordinated with other pain treatment programs (cf. Projects R-61 and R-63, University of Washington) in order to enhance the use of current knowledge, avoid duplication and coordinate interviews and questionnaires with data being collected at other treatment centers. Approximately 30 patients admitted to the Pain Treatment Program, 30 patients accepted but not admitted, and 30 patients rejected for treatment will be evaluated by means of a questionnaire and an interview with a social worker or psychologist trained in the evaluation of chronic pain problems. They will also retake the MMPI. Spouse or other significant person in their lives will be evaluated when these individuals are evaluated as part of the initial intake assessment.

FINDINGS TO DATE: Follow-up study is nearing completion and data is being collated and analyzed. Data from 125 people has been coded and keypunched and analyses are in progress. Preliminary observations indicate that 75% of the patients continue to maintain the gains achieved in the program. They seem to be supporting themselves, to be active recreationally, and to be taking fewer drugs. Many have taken steps to improve unsatisfactory living situations. Contact was made with the University of Washington to compare methods and preliminary findings.

APPLICABILITY: The claims of a high rate of successful treatment in behavior modification of pain programs have often motivated chronic pain patients to undertake the difficult and costly inpatient treatment program. Other patients severely disabled by chronic pain are not being referred to pain treatment programs of this type because success rates have not been clearly documented. Documentation of this data is important for future patients, for referring physicians and for those responsible for paying the costs of inpatient treatment as well as the extremely high costs of chronic pain not successfully treated. Specific factors identified as indicating potential for successful treatment will be useful to physicians, insurance companies, vocational rehabilitation personnel and workman's compensation programs in considering the recommending and financing of such treatment for their patients or clients. Identification of factors predicting unsuccessful treatment will also significantly reduce costs.

041 A Functional Assessment Inventory for Rehabilitation Evaluation (formerly A Functional Limitation Scale for Rehabilitation Evaluation)

Principal Investigator:	Nancy Crewe, Ph.D.	
Status:	Continuing	
Dates:	October 1977-September 1979	
Cost:	Annual \$64,399 RT Annual \$55,768	Projected Total \$80,000 RT % of Annual Total 87%
Annual Report Reference:	#17, Page 223, R-67	

OBJECTIVES:

1. To refine the preliminary version of the Functional Limitations Inventory (FLI) into a helpful tool for

University of Minnesota

rehabilitation counselors:

2. to determine the validity of the scale for predicting vocational outcomes with disabled persons;
3. to evaluate the usefulness of the FI in classifying severity of disability; and
4. to evaluate the effectiveness of the FI for grouping patients who present similar rehabilitation problems.

METHODOLOGY:

1. The Pilot phase involves Scale expansion and reliability testing. The following aspects of the scale will be examined potentially critical assets that may find the impact of functional limitations: existing coding conventions; preliminary reliability conventions and testing; a new series of interviews; and inter-rater reliability coefficients.
2. The Validation phase will involve counselors from settings other than the University of Minnesota. A large number of subjects will be located. Training programs and materials for participating counselors will be developed. Counselors will complete the FI on 30 clients and then follow up the clients at specified intervals. The relationship between the FI and the follow-up criterion will be investigated. A manual on the FI will be developed.

FINDINGS TO DATE: The Pilot phase has been nearly completed and work has begun on the Validation phase. Each item was reviewed and 9 strength items were added. Fifteen vocational counseling interviews were observed, inter-rater reliability was assessed, and items were clarified. Contact has been made with the Minnesota Department of Vocational Rehabilitation concerning the inclusion of their counselors in the field testing.

APPLICABILITY: Current RSA priorities recognize the need for more adequate definitions of severe disability and measures of functional capacity that will guide the rehabilitation process to optimal physical, psychosocial, and vocational outcomes. Also a need exists for more accurate prediction of vocational rehabilitation outcomes. The FI has potential bearing on these concerns.

042 Evaluation of Outcome of Rehabilitation Measured by Costs of Rehabilitation and Maintenance and Changes in Quality of Life (formerly A Method of Measuring Some Patient Characteristics, Goals, Results, and Costs of Medical Rehabilitation)

Principal Investigator:	Frederic J. Koffie, M.D., Ph.D.
Status:	Continuing
Dates:	October 1976-October 1979
Cost:	Annual \$164,174 RT Annual \$92,601
	Projected Total \$180,000 RT % of Annual Total 56%
Annual Report Reference:	#17, Page 229, R-68

OBJECTIVES

1. To document gains made by patients on a general rehabilitation service as a result of participating in medical rehabilitation programs;
2. to compare goals set at admission with gains made;
3. to assess the functional utility of gains;
4. to measure the durability, after one year, of gains made while in the hospital;
5. to assess the cost of achieving rehabilitation gains; and
6. to apply the method of measuring patient progress to a large number of general rehabilitation patients.

METHODOLOGY: The patient description forms developed in R-45 have been used to obtain data on 150

patients. Data is stored in a computer. Methodology is being developed to collect annual follow-up data on patients discharged from the Rehabilitation Center. For 185 stroke patients followed after discharge, when patients and families were adequately trained and followed up, the gains of rehabilitation were maintained until supervening additional disability or death further impaired performance.

FINDINGS TO DATE: Work has continued on objectives 1, 2, 3 and 6. Because of computer problems, the data is being transferred to a larger computer. Levels of performance are indicated by: intact (6); limited (4); helper (2); and null (0). Change of status is being evaluated and recorded on a variety of problems.

APPLICABILITY: Both the quality and outcomes of health care are scrutinized by this project. The cost of Social Security Disability Insurance in supporting the disabled is enormous. Only through rehabilitation can the disabled re-establish self-sufficiency. The identification of techniques of adequate rehabilitation will be of benefit to both the patient and the government agency that supports the cost of disability.

043 An Investigation of the Cause and Prevention of Ischemic Ulcers

Principal Investigator:	Robert Patterson, Ph.D.	
Status:	Continuing	
Dates:	July 1977-October 1981	
Cost:	Annual \$56,079 RT Annual \$45,661	Projected Total \$185,000 RT % of Annual total 81%
Annual Report Reference:	#17, Page 236, R-69	

Part I

OBJECTIVES

1. To obtain continuous recordings for periods of 8 hours of the pressure and temperatures over the ischial tuberosities and/or posterior surface on both normal and spinal cord injured persons;
2. to correlate the pressure-time patterns of patients with no history of ischemic ulcers with patients who have developed ulcers; and
3. to estimate the frequency and duration of push-ups needed to prevent ischemic ulcers.

METHODOLOGY: Data will be recorded on a small, portable four channel tape recorder (Medilog) able to record data continuously for 24 hours. Small, thin pressure transducers will be used to record the pressures over the ischial tuberosities. A LINC digital computer will reduce the data. The capillary pressure of 32 mmHg will be carefully studied.

FINDINGS TO DATE: Equipment was obtained, calibrated, and five types of pressure transducers were investigated. Three normal subjects have been monitored.

APPLICABILITY: Data on the frequency and duration of push-ups or shifts in the position that spinal cord injured patients must do to prevent the development of ischemic ulcers would greatly aid in the creation of a workable program to prevent ulcer generation. The generation of ischemic ulcers is one of the major medical problems that causes repeated hospitalization and loss of work time for spinal cord injured patients.

Part II

OBJECTIVE: To study the effect of the Med Rest and ROHO wheelchair cushions on skin temperature and surface skin pressure immediately over the ischial tuberosities and the posterior thigh.

METHODOLOGY: Ten able bodied persons will be tested on the ROHO cushion and a 4-inch foam pad. The room and equipment will be maintained at 25°C. The individuals, disrobed and with Yellow Springs thermalinear components taped to their skin directly under each ischial tuberosity and thigh will sit quietly for 30 minutes. Pressure transducers will be attached on separate occasions and oral body temperatures will be measured. The data will be monitored by a Gould model 481

recorder and a digital printout will be obtained every 60 seconds on an analog model 2510-3-1/2 digit panel meter.

FINDINGS TO DATE: The average resting surface sitting pressure on the ROHO^(R) cushion was 55 mmHg. The 4-inch foam cushion pressure was 7.5-10 mmHg greater. These differences were not statistically significant. The increases of skin temperature using the ROHO cushion were 1.8°C and 2.9°C. These results are similar to a previous study done on the 4-inch foam cushions. The Med Rest^(R) mechanical resting surface was not evaluated as the device is off the market pending new modifications. This project is now completed.

APPLICABILITY: The findings of the study on the characteristics of seat cushions will have immediate and direct applications in the prescriptions of proper wheelchair cushions. Hopefully this will decrease the occurrence of expensive and debilitating decubitus ulcers.

044 Social Skills Training for Young Adults with Cerebral Palsy

Principal Investigator:	Jerry Martin, Ph.D.	
Status:	New	
Dates:	October 1977-September 1981	
Cost:	Annual \$16,213 RT Annual \$11,541	Projected Total \$40,000 RT % of Annual Total 71%
Annual Report Reference:	#17, Page 244, R-71	

OBJECTIVES

1. To identify social situations that commonly elicit maladjustive social behavior from young adults with cerebral palsy;
2. to develop a training program to deal with these situations;
3. to assess the generality and durability of the social skills training program; and
4. to assess the effect of the program on work or program suitability.

METHODOLOGY: An intensive survey will identify problem social behaviors in young adults with cerebral palsy. These behaviors will be compiled into a Problem Situation and Behavior List that will form the basis for the social skills training package. Young adults with cerebral palsy at the University of Minnesota Rehabilitation Center will be exposed to the training package in daily individual sessions. Reassessment of individuals will be made at specific intervals. The adaptability of the training package to group settings will be assessed.

FINDINGS TO DATE: A large portion of this year's activity was devoted to rethinking and revising the project in response to the feedback provided by the Peer Review Site Visit, 1977. The first portion of the extensive survey to identify problem social behaviors has been completed.

APPLICABILITY: Personality and social adjustive problems in adults with cerebral palsy have been major deterrents to employment and job success. Only when social-adjustive barriers are removed will the true potential of these individuals be known.

045 Energy Cost, Blood Pressure and Heart Rate Studies During Sexual Intercourse

Principal Investigator:	Joseph Bohlen, M.D., Ph.D.	
Status:	New	
Dates:	October 1977-September 1979	
Cost:	Annual \$52,984 RT Annual \$25,797	Projected Total \$75,000 RT % of Annual Total 49%
Annual Report Reference:	#17, Page 252, R-72	

OBJECTIVE: To determine the energy cost during sexual intercourse by measuring heart rate and blood pressure in normal and coronary subjects during sexual activity.

METHODOLOGY: Ten volunteer married couples will be thoroughly examined and exercise tested. Each couple will have an intercourse session with all electrodes in place but not recording. During masturbation and intercourse sessions various parameters will be continuously monitored. Couples will record blood pressure and heart rate during intercourse at home with portable ECG recorders and automatic blood pressure recorders.

FINDINGS TO DATE: This research project has been delayed because of Dr. Ozel's sudden death. Dr. Bohlen will continue the research. Testing of subjects is scheduled to begin the fall of 1978.

APPLICABILITY: Obtaining information on the energy cost and hemodynamics of sexual intercourse will help post myocardial infarction patients to save their physical and emotional health, as well as their marriages and futures. Patients who can return to a premorbid sexual level will be more emotionally stable, perform their reconditioning programs more willingly, and return to their jobs faster.

046 Radiographic Study of the Restriction of Spinal Mobility Using Thoracolumbosacral Orthoses

Principal Investigator: Seth Rosenbaum, M.D.

Status: New

Dates: October 1977-October 1979

Cost:	Annual \$16,923	Projected Total \$11,970
	RT Annual \$5,570	RT % of Annual Total 33%

Annual Report Reference: #17, Page 256, R-74

OBJECTIVES

1. To study the effectiveness of three commonly used TLS orthoses on the range of motion of TLS spine in sagittal plane using roentgenographic method; and
2. to compare clinical methods of assessing range of motion of back using radiographic data.

METHODOLOGY: Ten healthy adult males will be assessed clinically for range of motion of the back and x-rayed in neutral maximum flexion, and extension positions. They will then be fitted with each of the three orthoses. The lateral standing spine films will be repeated and the inter-vertebral motion will be calculated. Radiographic data will be used to compare clinical measurements.

FINDINGS TO DATE: Initial subjects have been studied but data is not yet sufficient to be meaningfully analyzed.

APPLICABILITY: An understanding of what a particular TLS orthoses can and cannot do is very important when prescribing this expensive apparatus. The data from this study will be valuable in proper brace prescription which will lead to early mobilization and rapid rehabilitation of patients with back disabilities.



**University of Washington (RT-3)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Bioengineering

Biophysics: The bioeffects of nonionizing radiation (electromagnetic, high frequency current, acoustic wave propagation, radiant and conductive heat) resulting in improved designs of therapeutic applicators in the various modalities for safer and more effective use. The basic rationale for the use of specific methods to heat specific human structures is described. National and international standards for safety and efficacy are also discussed.

Biomechanics: Detailed theoretical and actual study of lower extremity biomechanics. The quantification of force interactions between limbs and orthoses has resulted in the more precise fitting of orthotic design to patient need. Analyses of commercially-available and experimental orthoses continue to be made.

Engineering Applied to Clinical Problems: The development and evaluation of adaptive aids through human factors engineering to contribute to improved clinical service.

Behavioral Sciences

Research predominantly centered around the introduction of learning-based behavior modification strategies to traditional rehabilitation by increasing self care skills in the physically disabled and decreasing the impact of chronic pain. Work is focused on those items which might be predictors for success or failure in a contingency management program. Biofeedback represents another more specialized technological application of learning-based strategies to be examined. Additionally, different treatment methods in speech and communication will be reviewed for their effectiveness.

Neurophysiology

Elevating the knowledge of neuromuscular electrodiagnosis and discoveries of animal models for various human crippling disorders.

Muscle Physiology

Maximizing positive functions of normal or diseased muscle and minimize secondary disabilities resulting from damaged or impaired muscle.

Health Care Delivery

A series of projects related to the improvement of efficiency and quality of health care, whether through the expansion of training to meet demand or the study of the cost-benefits of rehabilitation outcomes of certain categorical diseases.

Multiple Sclerosis

Activities designed to improve the rehabilitation of disabled individuals with multiple sclerosis through research into major problems such as dysfunction of the urinary bladder, psychological dysfunction, speech and communication dysfunction, and weakness; to assess the actual reasons why MS patients do not work and identify comprehensive rehabilitation needs; and to promote and provide better diagnostic and prognostic specificity for this disability group.

UNIVERSITY OF WASHINGTON

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COMPLETED

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- Severe Physical Disabilities of Unknown Etiology: A Study of Antigens Producing Paralytic Disease
- Development of a Portable Urine Flow Monitor
- Development of an Objective Method for Evaluation of Viscoelastic Properties of Joints

University of Washington

PROPOSED

Development of an Engineering Applications Program
Telemetric Method of Monitoring Pathophysiological Voiding
Development of a Wheelchair Attachment for Long Range Ambulation
Development of a Clinical Measurement System
Vibratory Feedback for Individuals with Brain Injury
A Study of Third Party Payer Response to Purchase Requests of Communication Augmentation Equipment
Computer Analysis of Word and Phrase "Vocabularies" Used by Non-vocal Adults
Adaptation of Microcomputer as Non-vocal Communication Equipment
Determining the Distal Latency of the Superficial Radial Nerve in Normal Adults
Monopolar Needle Electrode Parameters
A Nerve Conduction Study of Ulnar Nerve Compression Syndrome at the Elbow
Influence of the Basal Ganglia on Different Aspects of Motor Performance
Temporal Course of Reflex Recovery Following Spinal Cord Transection in Adult Cats
Physiological Characterization of Newly Identified Afferent Inputs to the Globus Pallidus
Motor Point Blocks Phase IV
Psychological Correlates of Traumatic Head Injury and Recovery of Function
Development of an Assessment Tool for Motor Performance in Cerebral Palsy
Social, Psychological and Intellectual Functioning in Two Groups of Patients with Multiple Sclerosis
Effect of Exercise on Multiple Sclerosis
Lifestyle Changes Secondary to Communication Disorders among Individuals with Multiple Sclerosis

047 Postoperative Care of Patients with Total Hip Joint Replacement Using Ultrasound

Principal Investigator:	J.F. Lehmann, M.D.	
Status:	Completed	
Dates:	August 1971-July 1978	
Cost:	Annual Not Specified RT Annual Not Specified	Projected Total \$88,788 RT % of Annual Total Not Specified
Annual Report Reference:	#17, Page 77, R-2	

OBJECTIVE: To assess whether ultrasound can be used safely in an area which has a prosthetic joint incorporating methyl methacrylate and high density polyethylene.

METHODOLOGY: An ultrasonic transmission line will be used to measure the acoustic properties of methyl methacrylate and the high density polyethylene. The longitudinal and shear velocities as well as the loss in the longitudinal shear modes will be calculated. The sample of methyl methacrylate will be prepared according to the directions supplied for preparing the materials for surgical use. Pieces of material will be machined to allow placement in the transmission line. Measurement of density will be made using the standard displacement technique and specific heat will be measured with a calorimetric method. The measurement of thermoconductivity will be made in a thermodynamic laboratory.

FINDINGS TO DATE: Having determined the absorption characteristics of the materials involved, the rationale was developed for evaluating four-layer media made up of various combinations of the following materials: muscle, bone, metal, polyethylene and methyl methacrylate. The basic factor which influences heating in these materials is the degree of transmission and reflection occurring in various thicknesses of the layered media.

In specific cases, maximum transmission occurs when the thickness of a material is equal to $2/2$ or even multiples of $2/4$. Maximal reflection occurs when thicknesses of the material are odd multiples of $2/4$. Altering the transmission or reflection within the multi-layered media changes the amount of energy present in each layer which can then be absorbed and produce heating.

Highest absorption was determined to be in bone and in the polyethylene, next in the methacrylate and in muscle, and the lowest in the fat layer. Extremely low absorption occurs in the metal layer since the energy is either transmitted almost totally or almost totally reflected depending on the thickness of the metal layer. Examination of all combinations of layer thickness and layer placement showed highest temperatures occurred in bone in all cases except when a polyethylene layer was introduced in front of the bone and had a thickness near or over 1 cm.

It is therefore concluded that if there is viable bone in the field which is not located behind approximately 1 cm of polyethylene that the highest temperature in the field will occur in the bone. Thus sensation of periosteal pain will indicate that temperatures approaching or exceeding tolerable therapeutic limits are being reached.

The second factor demonstrated was that a very wide variation in heating patterns can occur due to small variations in layer thickness. This indicates that because there are very small areas of the tissue with uniform thickness, localized heating in any of the non-biologic materials would not allow selective "hot spots" to occur. In addition, the ultrasound is applied with a moving applicator in which the angle of incidence is constantly being varied, causing further variation in contributing shear waves, which produce heat primarily in the bone.

A paper describing this project has been accepted for presentation at the 1979 Congress of Rehabilitation Medicine in Honolulu.

APPLICABILITY: Ultrasound application could be a valuable adjunct in the postoperative care of the total hip procedure. Vigorous application of ultrasound to heat the structure around the hip would increase rate of heating and possibly reduce pain, making the patient a functional ambulator in less time, if this technique is safe.

048 Motor Point Blocks Phase III

Principal Investigator: B.J. deLateur, M.D.
Status: Completed
Dates: July 1973-June 1978
Cost: Annual \$1,437
RT Annual \$1,150
Projected Total \$23,375
RT % of Annual Total 80%

Annual Report Reference: #17, Page 475, R-92

OBJECTIVES

1. To determine appropriate voltages for precise localization of motor nerves;
2. to correlate lesion size with magnitude and duration of temperature; and
3. to determine and improve the accuracy of localization of the lesion for studying, histologically, the character, evolution, and duration of the lesion.

METHODOLOGY: The motor plates and small intramuscular nerves will be localized in guinea pigs. An electrosurgical system suitably interfaced with probing needles will be utilized to deliver a low output current to the motor points and small intramuscular nerves.

The animal is sacrificed after two days to get good necrosis and inflammation. The gastrocnemius muscles are excised and placed in formalin. The Holmes Nerve Fiber stain is used to determine what the site and size of the damage is and whether the nerve itself has been affected. A functional test of damage to the live animal will not be done at this time since these are acute lesions and any damage seen might be due to soreness.

The lesion should be of the nerve, leading to wallerian degeneration, and to atrophy (not necrosis) of the muscle.

FINDINGS TO DATE: From histology on the first two guinea pigs, it was concluded that 45°C and 60 seconds would be sufficient temperature and duration of current to make a satisfactory lesion.

In the subsequent 8 animals, one lesion was made in each gastrocnemius muscle at points which were most responsive to stimulation. The animals were sacrificed and the muscles excised, after at least two days, and serial sections were done to determine the true extent of the lesion and the proximity of the lesion to peripheral nerves.

The lesions were from 3 to 4 muscle fibers in thickness. It can therefore be concluded that the lesion of controllable size was produced. In spite of careful attempts at localization, no damaged nerve fibers were seen in the vicinity of the lesion.

Since this study had demonstrated that the methods used will produce a lesion of controllable size, it is proposed to use the radiofrequency lesion generator to control spasticity in human subjects who have stable lesions.

APPLICABILITY: If the option of a permanent motor point block becomes available to handicapped patients, it will mean that they can have relief without interrupting their work or activities every 4 to 6 months to return for repeat blocks. This is of particular relevance to those who live a great distance from a center where blocks are performed.

049 Gastrocnemius Muscle and Tendon Length in Normal and Stroke Patients

Principal Investigator: E.M. Halar, M.D.
Status: Completed
Dates: December 1974-December 1978
Cost: Annual \$6,957
RT Annual \$6,095
Projected Total \$27,264
RT % of Annual Total 87%

Annual Report Reference: #17, Page 463, R-104

OBJECTIVES: To develop a reliable technique that could accurately measure muscle belly and tendon length changes during different active or passive ankle ranges of motion.

To determine whether loss of passive dorsiflexion in a stroke syndrome is due to a shortening of the muscle belly, or of the tendon, or both.

METHODOLOGY:

1. Human gastrocnemius muscle belly and tendon lengths will be determined through the use of ultrasound echography at several points on the leg.
2. Both normal subjects and stroke patients of varying age groups will be measured when their legs are both passively dorsiflexed and relaxed. This will establish a tension length diagram.
3. Elasticity as a function of age will be measured through the determination of muscle belly and tendon lengths of several passive tensions.
4. Ten consecutive measurements of a single limit under a single passive tension will determine how many scans should be made for any single subsequent measurement. A normal young adult group (ages 20-30) and a normal older group (ages 55-65) will be compared for right-left leg variations and age variations and will be matched according to lower limb length.
5. Fifteen to twenty patients having suffered unilateral stroke syndrome will receive prolonged passive stretching and measurement of their right and left leg with the opposite serving as control, for 20 minutes, twice a day and lasting a period of 3-4 months. These patients will be compared to each other and the normal group.
6. It was decided to test 60 subjects, 30 normals and 30 stroke patients for the part of the study regarding shortening and elongating properties of the gastrocnemius muscle. An additional 30 stroke patients will be tested for the treatment of the gastrocnemius muscle contracture.

FINDINGS TO DATE: (Conclusions)

1. In normal and hemiplegic subjects, only the gastrocnemius muscle belly elongates or shortens during ankle ROM. The gastrocnemius tendon appears to be a rigid structure.
2. There was no statistical difference in elongation characteristics of the muscle bellies between hemiplegic and nonaffected legs of nemius muscle. The above findings, in comparison with the findings of "clinical contracture" indicate that the patients actually had a "functional" rather than structural contracture. These findings also indicate that the spasticity is the cause of the reduction of muscle resting length, but is not the cause of an intrinsic muscle contracture, at least not in early stroke syndrome patients.
3. The findings that average maximum elongation of muscle bellies of normal subjects are statistically greater than both nonhemiplegic and hemiplegic muscle bellies indicates that changes in both nonhemiplegic gastrocnemius muscle bellies are nonspecific and most likely due to inactivity of these patients.
4. Age does not influence passive elongation properties of normal gastrocnemius muscle whereas inactivity does appear to be a factor.
5. The only difference between hemiplegic and nonaffected muscle bellies was found during active and passive plantar flexion. At the beginning of passive or active plantar flexion, the hemiplegic foot is already in plantar flexion and total ROM is therefore reduced.
6. Spastic muscle belly shows smaller length changes in ROM with minimum passive tension, and relatively large ROM and muscle belly changes with maximum passive tension, though the total ROM and muscle belly change was found to be the same in hemiplegic and nonhemiplegic legs.

APPLICABILITY: Effective prevention and management of joint contracture is a question that is raised daily on Rehabilitation Medicine Services, or any other medical service dealing with chronically sick and disabled patients. The scarcity of published data in the Rehabilitation Medicine literature leads one to believe that much of the conservative and surgical treatment is done on an empirical basis. Knowledge about the basic mechanism of how live muscle becomes permanently shortened if not used would enlighten our conservative and surgical treatment of joint contractures.

050 Footwear and Posture: Phases I-V

Principal Investigator:	B.J. deLateur, M.D.	
Status:	Completed	
Dates:	May 1974-October 1978	
Cost:	Annual \$26,162 RT Annual \$23,287	Projected Total \$37,812 RT % of Annual Total 89%
Annual Report Reference:	#17, Page 140, R-107	

OBJECTIVES: **Phase I:** To study quantitatively what effect the heel height of footwear has on the lumbar lordosis when subjects are standing.

Phase II: To study quantitatively what effect the heel height of footwear has on the lumbar lordosis, the hip, and knee, when subjects are walking.

Phase III: To determine the short-term effects of heel height upon the angles between the bones of the foot (especially the longitudinal arch).

Phase IV: To determine long-term beneficial or detrimental effects of negative heel footwear upon the feet and back.

Phase V: To determine metabolic demands of different types of footwear.

METHODOLOGY: **Phase I:** Polaroid photographs were taken with subjects in bare feet, low heels, and earth shoes (men); or bare feet, high heels, and earth shoes (men); or bare feet, high heels, and earth shoes (women).

Lateral photographs were repeated five times in each position and the average intersecting angles and the standard deviation made. Koffke landmarks on the anterior superior iliac spine and posterior superior iliac spine were placed and a tape drawn between those landmarks. To that line a perpendicular was dropped to the greater trochanter. Also, a tape was placed connecting the lateral epicondyle of the femur with the greater trochanter. Thus, the true angle of the hip was measured and recorded. This served as an orienting landmark for the photography, to aid in reproducibility of the method.

Phase II: Electrogoniometry will be used to measure the angles of the low back, the hips, knees and ankles instantaneously throughout the gait cycle with subjects in bare feet (providing the normative data), negative heels, and positive heels of various heights.

Phase III: Subjects with normal or hypermobile flat feet will have cineradiographic films made of their feet as they walk on the treadmill in bare feet, negative-heel and positive-heel footwear. These motion-picture x-rays permit statistical analysis of the angles between the bones of the feet at all phases of the gait cycle of normal and flat feet in the various footwear to determine whether the long arch is "leveled open" in negative footwear.

Phase IV: A simple questionnaire regarding type of shoes worn most of the time and presence or absence of back pain and/or footpain is filled out by telephone. Subjects are telephoned every six months for a minimum of two years.

Phase V: Oxygen consumption studies will be made of subjects in bare feet, negative-heel shoes, low-heeled shoes of comparable weight, and high-heeled shoes, at varying level speeds, and with varying inclines on the treadmill.

FINDINGS TO DATE: **Phase I:** To determine whether or not negative heel shoes flatten the lumbar lordosis in standing, 16 subjects in tank trunks or bikinis had external markers placed from which lumbar-spine, hip and pelvic tilt angles could be measured. Five lateral photographs were made with the subject wearing negative heel shoes, bare feet and low or high heels, for a total of 15 photographs for each. Seven subjects were photographed twice for a total of 23 series. Lateral x-rays were made of the spines of two subjects. Although some individual subjects showed significant back angle differences, on the average there were no significant differences among types of footwear.

Phase II: Fourteen subjects have been studied, eight of them twice, for a total of 21 sets of data. Preliminary analysis indicates that most of the compensation for heel height takes place in the

ankle. Very little difference is seen in the hip and knee. The data do not support the notion that high heels increase the lumbar lordosis or that negative heels decrease it. One highly consistent phenomenon among all shoes and subjects is that there is a much greater lumbar lordosis (10 degrees) with subjects standing as compared with walking. This may well explain the fact that many patients with back pain complain of greater pain when they are standing than when they are walking. The lordosis can be demonstrably decreased by elevating one foot on a small footstool.

Phase III: In the subjects examined, one with normal feet and one with flat feet, there was a tendency to lever open the longitudinal arch with negative heels; this tendency was greater in the subject with hypermobile flat feet than in the normal subject.

Phase IV: Thirty-three wearers of negative heels were contacted at intervals of not less than 6 months for reports on back, foot or other pain. Subjects had worn negative heels from 1 to 38 months for up to 112 hours a week. Thirteen subjects had complained of back pain before buying the shoes. Of these, 9 reported that their back pain stopped when they began wearing the shoes, and four of these continued to have back pain afterwards. Three of the four reported no change, another said back pain was present but diminished. Another subject, who had no history of back pain, developed back pain after wearing the shoes. Of these, five continued to have foot pain after wearing when they wore negative heels. Eight more subjects report foot pain after wearing the shoes. In addition another seven had foot pain while breaking in their shoes. Heel calluses were a common complaint with negative heels. Three persons reported the onset of knee pain after wearing negative heels.

APPLICABILITY: Mechanical or postural low back pain is associated with bad posture—mainly increased lumbar lordosis. High heels are said to increase this lumbar lordosis and aggravate such low back pain (although the published studies do not fully document this). Negative heel shoes, on the other hand, have a flat heel and are raised in the front, thus are said to improve the posture, so claim the manufacturers of the shoes. If negative heel shoes decrease the lumbar lordosis, they might be able to help postural low back pain.

Consumers of the results will be very widespread. A large number of students are wearing negative heel shoes. Until the results of Phases II, III, and V are in, no specific recommendations will be made. The results of this study will result in clearer concepts of use to the practicing physiatrist, orthopedic surgeon, and general practitioner of the effects of shoe-wearing on mechanical low back pain.

051 Mapping of Microwave Fields Surrounding Human Subjects under Diathermy Treatment

Principal Investigator:	J.F. Lehmann, M.D.	
Status:	Completed	
Dates:	August 1976-August 1978	
Cost:	Annual \$41,372 RT Annual \$33,219	Projected Total \$82,843 RT % of Annual Total 80%
Annual Report Reference:	#17, Page 120, R-132	

OBJECTIVE: The objective of this study was to measure and plot contours of equal field intensity around human subjects while they were being irradiated with electromagnetic energy by microwave diathermy equipment operating at 915 and 2450 MHz.

METHODOLOGY:

1. All measurements were carried out in an anechoic chamber, so precise field intensity levels around the subject can be obtained. Human volunteers of varying physical size will participate in this study. They will be placed in the anechoic chamber in a position which is typical of diathermy treatments. The position of the subject will depend on the area to be treated. Selected areas of the body that are frequently treated with diathermy will be used—tight joints, anterior and posterior shoulder, contractor of the biceps, the lower back and contractors of the thighs. The selected area will be treated with microwave applicator operating at 915 and 2450 MHz.

2. An X-Y-Z co-ordinate tracking system with a National Bureau of Standards energy density probe attached will be shielded and placed in the anechoic chamber. This device will be computer-controlled to follow isobars of power densities with limit switches to set the area that is to be scanned. The computer will position the probe and also plot the field intensity levels in relation to distance from the diathermy applicator. This facility will allow us to make many measurements in a short period of time of microwave exposure.
3. Instrumentation will include the following:
 - a. National Bureau of Standards power meter: measures the power density in an electromagnetic field. Frequency of 10 MHz-3000 MHz accurate to 1.0 DB.
 - b. X-Y-Z tracking system. This is a commercially available system that was purchased and modified to be controlled by our Honeywell Computer.

The N.B.S. probe is attached to this system so it can be moved in any of three coordinates. A zero point is set by the operator and this is placed in the computer. A grid is then set up and the computer directs the tracking system to move in the increments defined, 1 cm-2 cm, etc. The computer then moves the probe throughout this grid while recording the power density measurements at each point.
 - c. Thermistor power meters will be used to monitor the incident and reflected power going to the applicator.
 - d. Microwave generators operating at 915 and 2450 MHz will be used to supply power to the antennas.
 - e. The contour lines of power density will be plotted on standard X-Y recorder.

FINDINGS TO DATE: This project was split into two parts. In the first part, the isopower density lines were measured near phantom tissue models while the models were irradiated by microwave diathermy applicators. Four tissue models were used: a bilayered planar model, a large diameter right cylinder, a small diameter right cylinder, and a thigh shaped model. Four diathermy applicators were used to irradiate each of the models: (1) a Burdick 2450 MHz E-director; (2) a Burdick 2450 MHz C-director; (3) a 2450 MHz circularly polarized Transco applicator; and (4) a 915 MHz linearly polarized square applicator. Extensive measurements were made of the microwave stray radiation around the models and applicators. The maximum distance was determined from the applicator/model interface to the 5 and 10 mW/cm² power density levels, when input net power was normalized to 50 Watts for the 915 MHz applicator and 20 Watts for the 2450 MHz applicators. In the second and more detailed part of the study, the four diathermy applicators were used to irradiate four human subjects of varying physical size. The anatomical sites which were exposed were the thigh (quadriceps), the lower back (lateral lumbar), the upper back (trapezius), elbow, the upper arm (biceps), the postero-lateral and antero-lateral aspects of the shoulder, and the postero-lateral aspect of the neck. In cases of human exposure, power intensity levels were on the order of one watt net. The planes which contained the maximum power intensity levels were determined, as well as the maximum distance from the applicator/tissue interface where 5 and 10 mW/cm² power intensity levels occurred.

Finally, anatomical sites commonly treated therapeutically were exposed to microwave radiation; and stray radiation levels were measured at sensitive organs, e.g., the testes and the eye, to determine the levels of stray radiation produced at these locations when net power was normalized to 50 Watts (915 MHz) or 20 Watts (2450 MHz).

In analysis of the data, three basic factors became evident: (1) direct contact applicators produce much less stray radiation than the conventional dipole antenna with reflectors (C- and E-directors) (2) The amount of stray radiation depends on the amount of contact between the applicator and the tissue. When the tissue completely covers the aperture of the applicator, stray radiation is minimal. (3) In linearly polarized applicators, the amount of stray radiation is greater in the director of the E-field vector.

Therefore in clinical use, direct contact applicators should be preferred, and the therapist can reduce stray radiation by improving applicator-tissue contact. In addition, overexposure of sensitive organs can be avoided by taking the direction of the E-vector into account when linearly-polarized applicators are used.

Any standards developed for equipment should require that the manufacturer furnish the therapist with adequate data on the E-field and stray radiation patterns produced, as well as on the heating patterns produced in the tissue. Since information on stray radiation cannot be transferred quantitatively from model to human, it is necessary to rely on the knowledge, understanding and skill of the physician and therapist rather than build a standard based entirely on performance with models. However, models remain highly valuable for testing heating patterns produced in tissue.

APPLICABILITY: Findings will be utilized by standard-setting agencies for medical devices, especially microwave diathermy equipment. Findings would also ultimately be used by practitioners.

052 Evaluation of Long-Range Wheelchair Ambulation

Principal Investigator:	C.G. Warren, M.P.A.	
Status:	Completed	
Dates:	September 1977-December 1978	
Cost:	Annual \$4,140 RT Annual 3,450	Projected Total \$15,000 RT % of Annual Total 69%
Annual Report Reference:	#17, Page 180, B-137	

OBJECTIVE: The objective of this study is to evaluate the use of a third wheel mechanism in long-range ambulation by paraplegic persons of various lesion levels and to compare its advantages over the conventional wheelchair, and to determine its limitations in negotiating inclines and in general maneuverability.

METHODOLOGY: A third wheel will be made available to this Center by the Werkendam Institute of the Netherlands. Any adaptations to allow it to fit American wheelchairs can be made at the Center. It is anticipated that these modifications will be minimal. The evaluation will be conducted on 9 patients, 3 with lesion levels of T6 through T10, 3 from T10 through L3 and 3 with L3 and below. A set of pre-test criteria will be established to ensure that each of the subjects is capable of utilizing the third wheel mechanism.

The first evaluation will be a rate/distance comparison to the two chairs on a level 0.6 mile oval track for a maximum distance of two miles. Rates of ambulation will be controlled by a speed controlled cart at rates of 7, 9 and 12 kilometers per hour. The three trials will be performed in the conventional wheelchair and in the chair utilizing the third wheel. The maximum distance traveled will be recorded.

In the second phase of the study, sections of the Seattle bicycle pathway will be used to evaluate the effectiveness in ascending and descending inclines of 6%, 9% and 12% over a distance of 1000 meters. The velocity/distance evaluation will then be conducted in the two chairs at 4, 6, and 8 kilometers per hour, with distance recorded. The final evaluation will be an obstacle course. Performance will be timed through a standardized system of barriers including ramps, curbs, a slalom and a concentric circle drill to establish minimum turning radius. Evaluation of incline will be performed on wet and dry pavement and over moderately rough terrain to evaluate traction.

FINDINGS TO DATE: All subjects were able to hand crank at a 49.8 watt level for four minutes, 2 of the 3 significantly exceeding this level. This demonstrates that the subjects were able to hand-crank workloads well above that required for standard wheelchair propulsion over level surfaces.

All times measured for half mile course were less for the third wheel than the standard chair. No large difference was seen in heart rate between the two modes of propulsion. When subjects in the third wheel were slowed down to maximum speed for the standard chair, heart rate using the third wheel rose at a much slower rate than the standard chair covering the same distance due to a larger muscle mass being used for hand-peddaling, distributing work over more musculature, or to the fact that less trunk musculature is needed for support. In crank propulsion, both antagonists and agonists are used reciprocally in a push-pull movement insuring the use of large muscle mass and less fatigue of isolated muscles.

Results of subjects propelling over the 0.8 and 4.1 percent inclines show better times for the third wheel for inclines of up to 4% for all three subjects. Heart rates again were not significantly different. A steep slope of 6.5% was about the maximum slope a subject was able to propel the third wheel a distance of 300 feet without traction problems and fatigue.

In a distance of 300 feet over grass, all three subjects made better times with the third wheel, due in part to the fact that the small caster wheels in the front of the standard chair are eliminated.

Timed trials were performed over various distances. With forms of locomotion requiring bodily energy expenditure, fatigue increases with increased distance, and it would be expected that times for set distances would become greater for greater distances due to the subject slowing down a result of fatigue. Fatigue rates for propelling the third wheel at maximum speeds over distances of up to one half mile were negligible. All three subjects were able to easily cover a course of 2.8 miles within 30 minutes at comfortable speed between 5.6 and 6.6 miles per hour. The third wheel appears well suited for long distances, producing minimal fatigue and allowing the person to go up to six miles per hour comfortably.

All subjects were able to go up a five inch street curb with the third wheel. Six inch curbs are the maximum height curb that can be safely handled with the third wheel.

Minimal turning radius was found to be four feet. The large front wheel eliminates any problems of going across slopes, which is found in the standard chair.

The apparatus is bulky and heavy (33 lbs.) and presents some transporting problems.

The wheel easily attaches to the standard chair. The wheelchair user who has the minimal balance problems has no difficulty in wheeling up to the apparatus, attaching it and cranking the caster wheels up. The attachment is easily chained to the standard bicycle rack.

In spite of its limitations, the third wheel was found to be better suited for outdoor use than the standard chair alone. A chair with improved design could show even greater differences. The third wheel has one large advantage over other three-wheeled vehicles in that it attaches and detaches from the wheelchair, and allows the wheelchair user to transport his wheelchair with him for indoor use.

Suggestions for improving the chair include decreasing weight of frame, minimizing turning radius and most importantly, adding a gearing system, offering up to five gears for hill climbing.

It is suggested that hand-pedaled, three-wheeled vehicles be further evaluated and recommended for the wheelchair user without upper extremity defects as a mode of transportation within the community, and as a recreational vehicle. Hand-pedalling needs to be further evaluated, specifically energy expenditure and more detailed study of the effect on the cardiovascular system.

APPLICABILITY Increasing the ability of the disabled to perform long-range ambulation may be a significant factor in their ability to take advantage of community life, specifically on campuses and in local community activities. It is also important to consider the limitations this device might have. Once they are defined, it may be possible to engineer modifications necessary to overcome some of the limitations.

053 Quantification of Efficiency of Aphasic Speakers on an Oral Picture-Description Task

Principal Investigator:	D.R. Beukelman, Ph.D.	
Status:	Completed	
Dates:	June 1977-June 1978	
Cost:	Annual \$7,072 RT Annual \$5,347	Projected Total \$4,715 RT % of Annual Total 75%
Annual Report Reference:	#17, Page 289, R-143	

OBJECTIVES To develop an objective, reliable and clinical useful method of quantifying language performance from language samples of aphasic speakers; to collect normative data; and to

determine if the sampling and quantification procedures developed in this study are sensitive to severity of aphasia, course of recovery, and non-fluent/fluent classification.

METHODOLOGY: Subjects will be asked to describe the "cookie theft picture" from the Boston Diagnostic Aphasia Examination, which is commonly employed as a stimulus picture for evaluation of aphasic speakers. The analysis of the speech samples will include several measurements: (1) speaking rate (syllables per minute); (2) oral communication efficiency (different concepts produced per minute); and (3) oral communication efficiency in correct grammatical structure per minute. Normative, severity and types of aphasia data will be collected and analyzed. In addition, the effects of recovery will be demonstrated over time.

FINDINGS TO DATE:

1. The study as described was completed.
2. Data was collected from thirty normal, geriatric adults ranging in age from 58 to 93 years with a mean age of 73 years.
3. Generally, the results of the study showed that there is an inverse relationship between the severity of aphasia and amount of information conveyed (content unit or concepts). However, mild and high moderate aphasic speakers tended to communicate as much information as normal speakers. Both measures of efficiency (content units per minute and syllables per minute) differentiated groups of high and high-moderate aphasics from normal speakers as well as differentiating low-moderate from mild aphasic speakers. Normal geriatric speakers produced descriptions with slightly less information at a slightly slower rate than did the normal adult.

APPLICABILITY: The documentation of improvement in communication function, the evaluation of high level aphasic persons, and the assessment of language function in running speech is closely related to the social, vocational and communication rehabilitation of persons with aphasia. The procedures examined in this study may improve our ability to assess the communicative skills of high level aphasic patients as the skills relate to vocational and social activities. These procedures may also permit the aphasic patient to be aware of his continuing progress as he reaches levels of performance to which the standard tests are insensitive.

054 The Natural History of Peripheral Neuropathy in Chronic Renal Failure: A Multivariate Clinical and Electrophysiological Study

Principal Investigator:	E. Halar, M.D.	
Status:	Completed	
Dates:	July 1977-July 1979	
Cost:	Annual \$13,397 RT Annual \$6,497	Projected Total \$12,000 RT % of Annual Total 48%
Annual Report Reference:	#17, Page 358, R-144	

OBJECTIVE: To study the natural history of motor and sensory involvement in renal patients, paying special attention to changes occurring before dialysis and during the first two years of dialysis. Electrophysiologic and clinical parameters will be correlated with amount of dialysis.

METHODOLOGY: Each patient will be simultaneously evaluated in three different areas. One area of study will involve an ongoing laboratory examination of the state of the patient's renal disease. Another area of study will involve electrophysiological measurement of motor and sensory nerve conduction velocities and H-reflex latencies. The final area of study will involve the assessment of muscle strength and sensory modalities, as well as the level of general physical function.

By repeating complete measurements every three months for the first two years of treatment, and by including some subjects who have had dialysis treatment for several years, we will be able to present a more complete picture of the natural history of motor and sensory function. We will attempt to correlate the factors and offer suggestions for determining the optimum frequency of dialysis to preserve nerve function in dialyzed patients.

FINDINGS TO DATE: Serial nerve conduction velocities (NCV) of median, peroneal, tibial and sural nerves and tibial nerve H-reflex latency were measured in 62 dialysis patients over a one and a half year period. Clinical sensory tests (CST) of proprioception, stereognosis, light touch, temperature, vibration perception threshold (VPT) and deep tendon reflexes were measured simultaneously on each patient. These patients were compared with a group of 31 age- and sex-matched controls. The objectives were to determine which of the electrodiagnostic tests and/or CST are the most useful in assessing the onset and progression of uremic neuropathy (UN). Results revealed the following: NCV and H-reflex latency values in uremic patients were significantly abnormal when compared to the controls (all $p < .001$). Abnormal H-reflex latency and NCV's were also found in those uremic patients tested during their first three months of maintenance dialysis (all $P < .010$).

All uremic patients with clinical sensory signs of UN had abnormal NCV results. Furthermore, 26 patients (41%) with normal CST had abnormal NCV findings. VPT measured with a biothesiometer was the most frequently abnormal CST finding. However, it was abnormal in only 19 (31%) of the patients. In early UN the electrodiagnostic tests displaying the largest percentile changes (obtained using Z scores) were tibial H-reflex latency (31%) and sural sensory NCV (22%). The most significant correlations with duration of dialysis were tibial and peroneal motor NCV's ($p < .001$). From these results it can be concluded: (1) electrodiagnostic tests are more sensitive than CST in assessing the onset and progression of UN; (2) tibial H-reflex latency and sural sensory NCV are the most sensitive electrodiagnostic tests in determining the onset of UN; and (3) tibial and peroneal motor NCV's are the most accurate tests to follow progression of UN. Therefore, H-reflex latency and sensory NCV are recommended to be used for assessing the onset of early UN and serial motor NCV's should be used in assessment of the progression of UN.

APPLICABILITY: Assuming that the objectives of the proposed research are totally fulfilled and that the resulting knowledge is fully utilized, the following benefits can be expected:

1. Individual benefit factors: Improved well being and personal function by prevention of neuropathy and muscle weakness, and return to work and financial independence.
2. Non personal benefit factors: Improved efficiency and effective use of treatment facilities, improved data quality.
3. This study should also provide an acceptable method for correlation of NCV's with data gathered from clinical observation and tests of sensation, reflexes, muscle strength and blood chemistry. Better understanding of the relationships that exist between these various parameters would be of considerable value in the prevention or improvement of sensory and motor functions in uremic patients, and therefore in their ultimate vocational rehabilitation.

055 Effects of Different Treatment Modalities on Range of Motion in Hemiplegic Patients

Principal Investigator:	S. Greenberg, O.T.R.	
Status:	Completed	
Dates:	January 1978-June 1978	
Cost:	Annual \$345 RT Annual \$0	Projected Total \$2,004 RT % of Annual Total 0%
Annual Report Reference:	#17, Page 259, R-146	

OBJECTIVE: To test the hypothesis that there will be a greater increase in active elbow extension in those hemiplegic subjects treated with kinesthetic biofeedback as compared to those treated with conventional occupational therapy, or those treated with a self-exercise (range of motion) program.

METHODOLOGY: Subjects will be matched according to age, sex, and general functional status; half will have a right hemiplegia and half will present a left hemiplegia. Using a random number table, subjects will be divided into treatment groups with equal numbers of right and left hemiplegic subjects in each group.

An initial and final assessment of range of motion and functional skills will be completed on each subject. Group I subjects will receive audio-visual kinesthetic feedback through an electrogoniometer strapped to the lateral aspect of the involved arm with the fulcrum at the elbow joint. A trip point will be set at the extreme of active elbow extension and a one inch green light will be activated when the subject is able to attain or surpass that range of motion. Group II subjects will be treated using conventional occupational therapy which has been determined polling eight occupational therapists in the greater Seattle area. Group III subjects will be taught a self range of motion program for elbow extension which they will carry out at home. The exercises will be revised as necessary at each session.

Each subject will serve as his own control in assessing the range of motion differences before and after treatment. The change between degrees of initial and final active elbow range of motion, scores on the Jebsen-Taylor hand function test, and the arc of function work space will be compared through analysis of variance between the three treatment groups and the sub-groups (right hemiplegics, left hemiplegics) within each treatment group.

FINDINGS TO DATE: Twenty subjects completed treatment programs, ten in an experimental treatment technique using kinesthetic biofeedback and ten in a control group consisting of a conventional occupational therapy approach.

Results suggest that kinesthetic biofeedback treatment was no more beneficial than conventional occupational therapy approach and also determined that an individual's age, sex, or length of time beyond one year post-CVA did not significantly affect treatment outcome. A majority of subjects in both treatment groups improved in ways not directly related to treatment, suggesting the need for long-term follow-up of hemiplegic patients.

APPLICABILITY: Kinesthetic biofeedback may serve as an adjunct to present rehabilitation therapeutic practices by relieving disability, increasing functional use of involved extremities, and permitting efficient use of time, space and professional services.

056 A System of Assessing Grammaticality in the Speech of High-Level Aphasics

Principal Investigator:	K. Yorkston, Ph.D.	
Status:	Completed	
Dates:	June 1978-June 1979	
Cost:	Annual \$5,980 RT Annual \$4,255	Projected Total \$5,980 RT % of Annual Total 71%
Annual Report Reference:	#17, Page 314, R-151	

OBJECTIVES:

1. To develop an objective, reliable, clinically useful method of quantifying the grammaticality samples of verbal output of high-level aphasic speakers.
2. To collect normative data.
3. To determine if the sampling and quantification procedures developed in this study are sensitive to severity of aphasia, course of recovery, and type of aphasia.

METHODOLOGY: Speech samples: Speakers will be recorded as they describe "The Cookie Theft" picture from the **Boston Diagnostic Aphasia Examination**.

Indices of grammaticality: In the present study, "string length" is used as a measure of grammaticality where a "string" is defined as a single word or a series of words which have a grammatical relationship to each other. This series of words need not be a sentence or contain elements of sentence structure such as subject or verb to be considered a "string."

A string is broken if two adjacent words are not grammatically related.

Analysis of speech samples: Each speech sample will be timed, transcribed and the following

measures will be obtained.

Total number of words: the total number of intelligible words in a response which are located in strings.

Total number of strings: the total number of strings within a response.

Mean String Length (MSL): MSL is the total number of words divided by the total number of strings.

Mean of the Three Longest Strings (M3LS): M3LS is the total number of words in the three longest strings of response divided by 3.

Treatment of the Results:

Normative data: Speech samples from 75 normal adults (45 young adults and 30 geriatric adults) will be analyzed in terms of MSL and M3LS. Central tendency and variability of this normative data will be obtained. Speech samples collected during Project R-143 will be included in this study.

Severity of aphasia: 50 aphasic speakers whose verbal scores on the PICA place them at or above the 50th percentile will be divided into three groups according to severity as follows: Group 1, 50th to 65th percentile; Group 2, 66th to 80th percentile; and Group 3, 81st to 99th percentile. Data obtained, i.e., MSL and M3LS, from the aphasic speech samples and the normal speech samples will be subjected to analysis of variance so that comparisons can be made (1) between the mean scores of the normal and high-level aphasic speakers and (2) between the mean scores of the different aphasia severity groups.

Type of Aphasia: The 50 aphasic speakers will also be classified according to type of aphasia. All of those speakers who can clearly be described as fluent or non-fluent (Goodglass and Kaplan, 1972) will be grouped. Data from speech samples will be subjected to analysis of variance in order to explore the relationship among the indices of grammaticality for normal, fluent aphasics and non-fluent aphasics.

Recovery: In order to investigate changes in grammaticality of verbal output during the course of recovery, five adult aphasic speakers whose overall PICA performance is at or above the 40th percentile within the two months of onset will be asked to describe the stimulus picture at monthly intervals over a six-month period of time. The PICA will be administered at monthly intervals as well. The speech samples of these speakers will be analyzed and plotted (i.e., on graphs of MSL vs. time post-onset and M3LS vs. time post-onset). The individual plots will be reviewed to determine if the data points shift toward the normal range as language performance improves as documented by overall PICA scores.

Reliability: Three measures of reliability will be obtained. **Intra-score reliability** will be assessed by asking all judges to rescore the randomly selected speech samples of five normal and five aphasic speakers. **Inter-score reliability** will be assessed by comparing the data obtained from four scorers when analyzing five randomly selected normal and five aphasic speakers. In order to assess test/re-test reliability, ten aphasic speakers whose verbal scores on the PICA place them at or above the 50th percentile will be asked to describe the stimulus picture twice in succession with approximately a one-half hour period of time between the two samples. Correlations between data obtained in the first and the second samples will be used to assess variability of this measurement technique.

FINDINGS TO DATE: Data collection and analysis was completed as described above. Results revealed an inverse relationship between severity of aphasia and both measures of grammaticality, MSL and M3LS. Although there is some overlap between the normal group and the highest groups of aphasic speakers, statistics show that MSL for mildly aphasic speakers is lower than for normal speakers. Results, however, suggest that mildly aphasic speakers are capable of generating grammatical strings as long as strings generated by normal speakers. Despite the fact that aphasic subjects' best performance (Mean of Three Longest Strings) is equivalent to the best performance (Mean String Length) does not match the overall performance of normal speakers. This gap between best performance and overall performance indicates reduction in efficiency. Because the measure of grammaticality studied in this project deal only with the form of the final product, it is impossible to say whether this reduction in efficiency is due to reduced grammatical knowledge, imprecise application of that knowledge or other problems which are not

grammatical in nature, such as word selection problems.

Analysis of the grammaticality of the speech of non-fluent aphasic speakers indicates that the best performance (M3LS) is reduced as compared to normal. The best performance and the mean performance are similar. Taken together, these measures suggest that grammatical performance of non-fluent speakers is both less diversified and less complex than normal. Examination of data derived from samples of fluent aphasic speech revealed that these patients are capable of generating complex structures but that overall performance does not match best performance because of word selection problems.

APPLICABILITY: The documentation of improvement of communication function, the evaluation of high-level aphasic persons, and the assessment of language function in running speech are closely related to social, vocational and communication rehabilitation. The procedures examined in this study may improve our ability to assess communication skills of high-level aphasic patients as those skills relate to vocational and social activities.

057 Program on the Quantification of the Effects of Electromagnetic Energy on Human Tissue

Principal Investigators:	A.W. Guy, Ph.D. R.H. Lovely, Ph.D.	
Status:	Continuing	
Dates:	January 1979-June 1980	
Cost:	Annual \$1,325,653 RT Annual \$51,117	Projected Total \$2,200,000 RT % of Annual Total 5%
Annual Report Reference:	#17, Page 82, R-5	

OBJECTIVE: To advance the existing knowledge on the quantitative effects of electromagnetic radiation on the human body and to provide realistic guidelines for safety standards of human exposure.

METHODOLOGY:

1. Establish quantitatively the electromagnetic field patterns both in and exterior to the tissues of human subjects and test animals due to external sources of energy.
2. Expose the test animals to the various CW and modulated electromagnetic sources at both thermal and lower levels while monitoring the energy of the tissues.
3. Observe the physiological and behavioral characteristics of the animals before, during, and after exposure to electromagnetic radiation.
4. Determine the time and power density thresholds for cataract production in animals exposed to microwave radiation.
5. Determine what levels of fields mankind can be safely exposed to, taking into proper account the source, configuration, frequency, and location.
6. The theoretical analysis involves solution of Maxwell's equation for the absorbed power by biological systems for a host of different geometries.
7. The experimental studies involve controlled exposure of test animals to selected sources of electromagnetic energy with the aim of quantifying observable effects and changes on the biological systems.

FINDINGS TO DATE:

Substudy 5b: Neurophysiological and Behavioral Effects of Microwave Radiation: Multiple experiment series of chronic microwave exposure studies at 915-MHz on rodents are complete, thus delineating the dose-response function for the primary bioeffects, the most sensitive of which has been a linear reduction in daily food consumption with increasing rates of microwave energy absorption (W/kg).

The primary objective of the work last year was to further examine the role that ambient temperature plays during chronic microwave exposure. The experiments addressed at examining the interactions have demonstrated that (1) even apparent low-level microwave exposure induces a series of thermoregulatory adjustments that appear as chronic exposure "effects," (2) these effects are extremely sensitive to, and dependent on, the ambient temperature as is the rat's success in adaptation to the treatment parameters, e.g., the rat will fare far worse at 10mW/cm² in a 26° C environment than it will at 20 mW/cm² in a 21° C environment, and (3) when a measurable rise in body temperature occurs, it does so because the animal's behavior and physiological accommodations which attempt to defend a narrow range of body temperature as measured colonically have been pushed beyond its control limits. However, these chronic accommodations (even without a rise in colonic temperature) have a detrimental effect on the animal's rate of synthesis and secretion of adrenal steroids to one-minute of ether stress as measured by plasma corticosterone levels 30 minutes following application of the secondary (ether) stressor. This shows that these thermoregulatory accommodations tax the stress capacity of the rat and thus these accommodations, when made on a chronic basis, are themselves stressful to the animal.

Substudy 5d: Effect of Microwave Radiation on the Nervous System:

1. Rats exposed three hours daily to 918 MHz (5 mW/cm², CW) microwave radiation through the first week of postnatal life were monitored through the first four weeks of life for body weight/mass, date of eye opening, as well as general physical development through 90 days of age. In addition, when the rats were young adults, their deep colonic temperature was assessed, as was their circadian rhythms. Then the animals were assessed in a fear/stress-motivated conditioning task to determine whether there are long-term proactive effects on the animal's adult behavior that are attributable to early postnatal exposure to microwaves.
2. The effects of microwave exposure *in utero* during the first twenty days of gestation in the rat with the exposure parameters were the same as the early postnatal exposure parameters and similar biological and behavioral variables were assessed in the newborn and, later, adult rodents. No effects consequent to postnatal exposure to microwaves (where the energy coupling is minimal), were found; a number of changes in the offspring of dams exposed throughout gestation 20 hours per day did occur. Newborn rats of the exposed mothers weighed significantly more than the offspring of the sham-exposed control rats. The former group showed acceleration for both single and double eye openings. Findings suggest that the microwave exposure might have accelerated the developmental process. By four weeks of age, however, the offspring of both the exposed as well as sham- and non-exposed groups could not be differentiated in terms of **any** developmental parameter or physical parameters typically employed in the assessment of teratogenic effects. However, both male and female offspring of the exposed dams showed pronounced and significant performance deficits when tested as adults in a conditioned (shuttlebox) avoidance response, thus implicating permanent (neuro) physiological/anatomical changes consequent to the gestational exposure which became manifest as permanent changes in adult behavioral relative to the control groups examined.
3. The assessment of microwave exposure on a chronic basis as it relates to the normal functioning of the CNS and behavioral output in the adult rodent was the final phase of the first year's research program. Adult rodent populations exposed for 8hrs/day for 7 days/week for up to four months to 5 mW/cm², CW, 918 MHz microwaves were examined daily for food and water intake, both in the home cage and exposure apparatus, as were body weights. A monthly clinical chemistry examined urinary ketosteroids, serum electrolytes, and blood sulfahydral activity as well as cholinesterase in blood. Animals were examined aperiodically during the four months of exposure for behavior repertoire and examined at the end of four months exposure for the evaluation for changes in open-field activity, shock detection threshold and avoidance conditionability. The only variance affected was that of food intake which was reduced significantly by the exposed animal's attempt to trade calories in maintaining their thermal equilibria.
4. The research protocol (behavior and biology) for the second year of research was nearly identical to that of the first year, with the exception that the carrier frequency for the polarized guided waves was changed from 918 MHz to 2450 MHz.

The adult behavior study carried out at 2450 MHz produced virtually identical effects in daily food reduction which could have been predicted on the basis of equivalent (SAR) dose response functions obtained at 918 MHz. No other endpoint examined revealed differences between exposed and sham-exposed groups.

On the other hand pre-natal exposure to 2450 MHz microwaves incident at 500 mW/cm² produced a number of provocative differences in the exposed rats progeny relative to control rats. In early development, the exposed rats showed a six- to seven-fold increase in post-natal mortality rate; those surviving showed significant losses in body weight relative to controls as well as inability to thermo regulate (females only) and 36-hour retardation in reaching the eye-opening milestone. As adults these rodents showed a significant increase in body weight (females only) as well as an overall facilitated performance in a shuttlebox avoidance conditioning task. Finally, adult male rats exposed prenatally showed an inability to maintain normal core body temperatures when challenged by cold stress for 8 hours. Based on these data, it is concluded that exposure to 2450 MHz microwaves during gestation induces a number of thermo regulatory and metabolic changes which in the case of the female progeny are suggestive of a functional ovariectomy.

Substudy 5g: Radio Frequency Radiation Effects on Cells: Both monkey lymphocytes and mouse tumor cells were exposed to 30 MHz RF fields at electric field strengths of 1, 5, 10 v/cm. The temperatures of the cell cultures were maintained at constant levels both at physiological and hyperthermic levels. The monkey lymphocytes were cultured and harvested at 24 and 48 hour intervals, both PHA-stimulated and non-stimulated cultures were tested. No significant difference was found.

Several of the early experiments on tumor cells carried out at physiological temperatures of 38° or lower, failed to reveal statistically significant evidence of cell damage by RFF at either 30 or 450 MHz, employing various electrical field strengths. However, two subsequent 30 MHz experiments exhibited RFF effects on neoplastic cells at the physiological temperature of 38°.

Apparent RFF-associated cell damage has been observed when similar experiments were performed under conditions of a highly controlled intentional hyperthermia. By imposing a uniform environmental temperature of 42° or 43° upon the neoplastic cells and, in addition, exposing them simultaneously to various RF field strengths of 30 MHz, striking differences between the subsequent behavior of the sham-exposed and RFF-exposed neoplastic cells were observed following reimplantation into mice.

A number of experimental and theoretical uncertainties remain that require further study in order to better understand the mechanisms and the implications of the observations. Irrespective of the outcome of the eventual analyses of these effects, the present results point toward a possible useful exploitation of the combined effects of cell or tissue hyperthermia and appropriate simultaneous RFF exposure, in experimental or applied cancer therapy.

The study on the effects of chronic RF exposure on the immune competence of mice has shown significant differences in tumor regression. The pulsed exposure was more effective than CW exposure. This experiment is being repeated. The total number of animals has been doubled to reduce the possibility of chance variation.

In vitro studies on the erythrocyte membrane showed no effects on the permeability of the membrane from both cw and pulsed exposures.

Substudy 5h: Biological Consequences of Pulsed Versus Continuous Wave Radiofrequency Radiation: In continued study the blood brain barrier (BBB) in mice, no effect has been found in mice from both CW and pulsed exposures even at hyperthermic levels. A positive control study using DMSO has shown that the BBB permeability is increased by DMSO injection. Rats are now being used instead of mice as the subjects.

No effect on rabbit heart rate was shown. There was no difference between pulse and CW exposure.

High power exposure has produced stun effects on rats. The threshold energy was 680J in rat head. The temperature rise was 8° C in brain tissue. This high energy exposure also disrupted the memory of the rats.

Substudy 5j: Determination of Electric Current Distributions in Man and Hanford Swine Exposed to a Uniform 60 Hz High Intensity Electric Field: Solid scale models of Hanford swine and man have been fabricated as master forms. With these forms a three-dimensional pantograph milling machine was used to produce hollow forms of the same shape as the master scaled to various sizes. These hollow styrofoam forms, scaled down 6:1 in size, have been filled with synthetic muscle

tissue and exposed in a VHF cavity. As a result of the exposure, the induced currents heat the synthetic tissues and thermographic measurements can be made of the specific absorption rate of the radiofrequency energy. This information has been extrapolated down in frequency to predict the current distributions in full-scale subjects exposed to ultra high voltage transmission lines. This information is allowing the extrapolation of data or observed biological effects in Handord swine exposed to high voltage fields to predict the consequences for the man chronically exposed to proposed ultra high voltage transmission lines used in the United States. A collaborative program has been set up with the Kiev Institute of Communal and General Hygiene so that such information can be exchanged with the Soviets who are also in the process of constructing such ultra high frequency transmission lines. This information is significant to physical therapists in terms of potential chronic effects of stimulation and galvanic currents used in connection with some therapies.

Substudy 5k: Chronic Low-Level Effects in Rabbits Exposed to 2450 MHz Microwave Radiation: Sixteen rabbits are being exposed to 2450 MHz continuous wave radiation at power density of 500mW/cm². They are irradiated 7 hours daily for a three-month period. Blood samples are drawn monthly from each rabbit to measure the chemical, hematological and immunological parameters of the blood. So far no difference between the exposed and the control group has been found. At the end of the study all animals will be sacrificed and histological preparations will be made. If no difference is found in all parameters the power density of the next 3 month study will be set at 5 mW/cm². Otherwise the power density will be set at 50 mW/cm².

Substudy 5l: Fabrication of 2450 MHz Chronic Exposure System for Exposing Mice: All waveguide constructions are finished. The whole system will be shipped to Oklahoma City. Two technicians will travel to there to set up the system. One of the principal investigators will fly there to make sure the system is operating properly.

Substudy 5m: Effects of Long-Term Low-Level RFR Exposure on Rats (Phase I): The study will involve two important phases of work. Phase I of the project lasting for an 18-month period (September 1978-March 1980) is being spent in preparation for the chronic study. These activities include construction of exposure waveguides, dosimetric measurements, setting up the exposure facilities and data acquisition systems, and performing pilot studies. Phase II of the project will involve the lifetime exposure and sham exposure of 200 rats.

The construction of 200 waveguides has been completed. The 100 control waveguides are similar to the 100 experimental waveguides except that no transmitting and termination transducers are attached to the two ends of the former. All 200 waveguides are housed in the 10 alcoves in the two T-wing rooms of the Division of Animal Medicine. The power distribution network is also being set up in the two rooms.

In order to stimulate human exposure to 450 MHz fields at 1 mW/cm² on rats, complete dosimetry studies using thermographic technique and twin-well calorimetry are being carried out on both rats and models of humans. After the dosimetric data are obtained, an incident power density for exposing rats will be determined. A two month "shake-down" study and a three month pilot study have been initiated.

APPLICABILITY: Applicable to improved clinical techniques such as diathermy and certain newly possible uses in medicine of microwave. The use of microwave energy in industrial, scientific and medical applications have increased the population at risk to unknown side effects. The close contact of our laboratory with federal authorities and the international collaboration of scientists will make the setting of standards possible.

058 Severe Disabling Polyneuritis of Unknown Cause: The Development of a Research and Treatment Model

Principal Investigator: G.H. Kraft, M.D.
Status: Continuing
Dates: January 1972-December 1979

Cost:	Annual \$8,452	Projected Total \$31,280
	RT Annual \$6,152	RT % of Annual Total 72%
Annual Report Reference:	#17, Page 350, R-19	

OBJECTIVES: To explore the relationship between experimental allergic neuritis and Guillain-Barre polyneuritis and to investigate means of therapeutic management and prevention of the disease.

METHODOLOGY:

1. Experimental allergic neuritis is induced in guinea pigs by a single intradermal injection into front footpads of an emulsion of peripheral nerve antigen in combination with killed mycobacteria in oil, an adjuvant which enhances the immune response.
2. The ensuing disease process, with clinical manifestations emerging on about day 14, is monitored in a variety of ways. Clinical observations, including the recording of weight and temperature (at the inside surface of the ankle) along with more subjective assessments of weakness and paralysis are made biweekly and with daily recording during the acute phase. Electrophysiologic examinations for indications of nerve function are performed twice weekly as well.
3. Further information is made available through the sacrifice of selected animals for routine and specialized histologic studies.

FINDINGS TO DATE: In experiments during previous reporting periods this was the first laboratory to develop *in vivo* electrophysiologic techniques—first latencies (19) and subsequently EMG and sciatic NCVs (4, 9)—to better assess and monitor EAN. Last year this work expanded, improving and developing new NCV techniques (21) and as the first group to study serial F wave in EAN. Studies started aimed at suppression, and 32 Lewis rats were used in an experiment to attempt to suppress experimental allergic neuritis. Experimental animals were treated with guinea pig peripheral nerve (GPPN) and incomplete Freund's adjuvant (IFA) before EAN was induced. It was found that in some cases this treatment actually potentiated EAN, producing a more severe disease which had an earlier onset in experimental as compared to control animals. Researchers concluded that the dose and injection schedule were critical in using GPPN and IFA to treat EAN. Because of limited funds, resources were not available during the year to carry out further experiments using the large numbers of animals that would be necessary to determine the proper treatment dose. Important information regarding the suppression of EAN by pretreatment with GPPN and IFA has been obtained.

Efforts this past year were also directed to compiling and analyzing data from several earlier experiments which have not yet been published.

APPLICABILITY: As a result of this and other studies, Experimental Allergic Neuritis has gained a high degree of credibility as a close and genuine model for the human Guillain-Barre syndrome. Information derived from this study, accessible to a large number of physicians and specialists in rehabilitation through presentations and publications, will be of use in treating the human disorder.

059 Mechanism and Treatment of Muscle Contracture in Disabling Diseases

Principal Investigator:	W.C. Stoltz, M.D.	
Status:	Continuing	
Dates:	September 1971-September 1983	
Cost:	Annual \$17,595	Projected Total N/A
	RT Annual \$12,420	RT % of Annual Total 70%
Annual Report Reference:	#17, Page 451, R-24	

OBJECTIVES: To simultaneously determine total muscle length, individual fiber length, number of sarcomeres, and length of tendon aponeurosis of insertion and origin in rat gastrocnemius and soleus muscle in which clinical contracture of normal and denervated muscle is produced.

METHODOLOGY: Fifteen adult rats will be weightmatched and divided into 3 groups of 5. One group will

be sacrificed immediately to represent initial condition, one will be immobilized via Plaster of Paris cast and the third group will be sacrificed at 5 weeks. The calcaneus of all the muscles will be separated from the feet, the gastrocnemius muscle will be separated from the soleus and the soleus muscles will be loaded with fifteen grams of passive tension. When the weights are loaded on the anesthetized animal the length of the muscle will be fixed by a perfusion of the animal with glutaraldehyde through the aorta. The soleus muscle will be dissected out and frozen on microtome stages and sectioned.

FINDINGS TO DATE

1. **Soleus immobilization contracture in young and mature rats:** Lewis strain rats were used in both the young, growing animal and the fully mature animal studies due to the fact that fully mature Sprague-Dawley rats (such as had been used in prior studies) were unavailable. The various parameters studied were the lengths of the total muscle belly, origin and insertion aponeuroses, anterior, middle, and posterior muscle fibers, and sarcomere length. From this, the number of sarcomeres per fiber and the total architecture of the muscle could be calculated.

Analysis of data shows that for young Lewis rats, the major contribution to immobilization contracture is due to both growth arrest and absolute reductions in the length of the tendon aponeuroses. When viewed from the anterior surface, 80% of the total reduction in muscle belly length is due to reduction in the origin aponeuroses length, while on the posterior surface 65% of the muscle belly length shortening is due to reductions in the insertion aponeuroses. Comparison of these results with the study performed in 1975-1976 using young Sprague-Dawley rats, in which 67% of the change on the anterior surface is due to changes in the origin aponeuroses and 74% of the changes on the posterior surface is due to changes in the insertion aponeuroses, shows that the major contribution to contracture in growing animals is alterations in the developing tendon aponeuroses. With the Sprague-Dawley young rats, the mechanism of change in the fibers and aponeuroses appears to be primarily growth arrest with some absolute reduction in the insertion aponeuroses. For the Lewis rats, both growth arrest and active shortening in the muscle fibers and tendon aponeuroses appear to be present. These differences noted here could largely be due to the slower growth rate and ultimate smaller size that Lewis rats exhibit as compared to Sprague-Dawley rats.

The old rat study indicates that the primary contribution to change in muscle belly length is change in the muscle fiber length. Viewed from the anterior surface, all of the change in the belly length is due to fiber shortening and for the posterior surface 65% of the change in belly length is due to fiber length reduction.

With this information, the greatest contribution to contracture in growing muscle appears as changes in the developing tendon aponeuroses and in fully grown muscle as changes in the muscle fiber. This suggests that immobilization contracture due to shortening of the affected muscle belly is due to changes in active metabolic structures (growing tendon, contractile muscle fibers), reflecting an active metabolic process.

2. **Soleus immobilization contracture in the baboon:** This study was run using a total of three adult male baboons. The first animal was primarily run to develop and perfect the techniques used in this study. Contracture was produced which indicates that after five weeks immobilization there was an average effective reduction in the range of motion of the ankle by 48%. This reduction in the range of motion of the ankle is accompanied by an average of only 10% reduction in the total length of the soleus muscle belly. When viewed from the posterior surface approximately 70% of the change in belly length is due to fiber shortening and 30% due to shortening of the insertion aponeuroses. From the anterior surface, approximately 40% of the muscle belly length change is due to fiber shortening and 60% due to shortening of the origin aponeuroses. In the baboon soleus, however, with the length of the aponeuroses being six to eight times that of the length of the muscle fibers, the 10% change in muscle belly length reflects a 5% change in aponeuroses length and a 33% reduction in fiber length, suggesting again the effect of immobilization contracture is primarily due to alterations in active metabolic structures.

APPLICABILITY: Muscle contracture secondary to positioning is best reversed by chronic positioning of the muscle in the elongated posture. Tendon lengthening procedures should be very carefully considered in the face of muscle contracture. In all growing patients with conditions productive of contracture, meticulous periodic posturing of the offending muscles in the elongated posture should inhibit the development of contracture and subsequent loss of functional ability.

060 Control of Spasticity with EMG Biofeedback in the Incomplete Spinal Cord Injured Patient

Principal Investigator:	J.C. Steger, Ph.D.	
Status:	Continuing	
Dates:	April 1975-April 1979	
Cost:	Annual \$9,947 RT Annual \$9,372	Projected Total \$25,000 RT % of Annual Total 94%
Annual Report Reference:	#17, Page 246, R-119	

OBJECTIVES: To determine the efficacy of surface electrode EMG feedback for decreasing spasticity in incomplete spinal cord lesions (where control may be possible).

METHODOLOGY: The effects of biofeedback will be determined by (1) monitoring surface EMG activity near the site of the spasm and providing visual or auditory feedback designed to enhance increased muscle relaxation in that area, (2) measuring spasticity (mean clonic frequency assessed in a standardized procedure—see methods) before and after feedback training to evaluate the extent of its change associated with decreased surface level EMG activity, (3) examining personality characteristics and mood before and after feedback training to determine the psychological impact of learning this self control procedure, and (4) correlating changes in mood and personality characteristics with objective changes in EMG readings, spasticity by the patient, and objective changes in range of motion, ADL capabilities, and activity levels.

FINDINGS TO DATE:

1. Pilot work completed to date includes identification of the major source of error: specifically, poorly defined measures of spasticity and the development of several alternative spasticity indices involving the use of goniometry. It was determined that duration, intensity, and frequency of spasm activity under standardized conditions could be measured by using a stabilimeter attached to a strip chart recorder.
2. Surface electrodes using J&J biofeedback equipment were demonstrated to reliably measure muscle activity which correlated from .88 to .94 with spasms as measured by the stabilimeter.
3. Self-report measures of spasm activity have been prepared and shown to correspond to patient reports of spasms and are ready for inclusion in this study.
4. The past equipment delivery delays and malfunctions have been remedied and circumvented and the hardware and methodology and preliminary work for this study have been completed and the study is ready to proceed.

A grant request was submitted to NIH for a person with training in biofeedback and patient interaction skills to complete this study, since funds were not available in the previous year for the technician needed to implement this design. The grant was approved but not funded as of June 1, 1979.

APPLICABILITY: This research may be of real benefit for spinal cord injured who suffer from the secondary disability of spasticity. Spasticity interferes with transfer ability and ability to concentrate on work tasks therefore interrupting vocational and educational goals, and plans. Frequently, the only method available to control the frequent spasms in the legs is heavy medication which causes loss of alertness. A simple treatment technique such as this one, if effective, might be most helpful in helping spinal cord clients return to work.

061 Rehabilitation Indicators: A Method for Enhancing Accountability (This project, RSA funded, appears nominally within RT-1. Work on the project is centered in RT-1, RT-3, VA Hospital, Brecksville, Ohio, and University of Georgia.)

Principal Investigator: W.E. Fordyce, Ph.D.
Status: Continuing
Dates: October 1974-October 1979
Cost: Annual \$3,047 Projected Total \$750,000
RT Annual \$747 RT % of Annual Total 25%
Annual Report Reference: #17, Page 507, R-125

OBJECTIVES: To develop a set of multi-dimensional (ADL, vocational, social) rehabilitation indicators that will be applicable to a broad range of disabilities (physical, sensory, MR, psychiatric), and in many types of settings (VR, medical rehab, VA, sheltered workshops, etc.).

To enhance accounting for the multi-phasic nature of rehabilitation services by developing indicators that can be used at various points in time.

METHODOLOGY: Rehabilitation indicators will be developed by each of three factor relevant task forces (ADL, Vocational, Social) that meet the following criteria:

1. Items are to be behavioral descriptors.
2. relevant to goals of clients and rehabilitation settings.
3. graded, scalable and potentially measurable.
4. potentially modifiable (behaviors have 'range').
5. generalizable across sets of clients, not idiosyncratic.
6. The placement of each item must be defined within the hierarchy of the branching system, and
7. the behavior described by the item must be consistent and reproducible.

Rehabilitation indicators may be used to develop client profiles, from which a weighting system may be derived. This proposed weighting system would assist in defining severity of disability functionally and also in helping to develop a weighted closure system.

The developmental phase of the Rehabilitation Indicators project is in its final stages. Two indicator Sets, Social/Leisure and ADL-Mobility, have been completed. The former has been receiving extensive field testing with RT-3 during the past year. Two additional sets, Vocational, and Environmental Status Indicators, are nearing completion.

FINDINGS TO DATE: This project has recently entered the third phase. Phase 1 was directed toward analysis of the problem and development of measuring instruments. Phase 2 focused on completion of instrument development and beginning of field testing. Phase 3 will focus on additional instrument development work, on completion of range of field testing sub-projects, and on development of training materials and dissemination programs.

More detailed reporting is available from RT-1.

The findings of R-125 from RT-3 support the conclusion that there is considerable potential for a measurement procedure which simply records the reported frequencies of engagement in selected activities. The methods seem to differentiate in ways that make sense. At this point the measurement of Activity Pattern Indicators seems to face three major issues. First there is the question of the contribution and importance in discriminating power of adding duration, level of assistance, and involvement of others in the recorded activities relative to the time/cost issue. Studies are presently underway which should shed further light on that matter.

A second issue concerns that extent to which the items will indeed discriminate in ways which are important among the diversity of target populations represented in various rehabilitation programs. That matter must of course await results from a variety of field testing studies.

Finally, there is the matter of data reduction and data refinement. It seems reasonable to expect that, once a spectrum of data are collected, it will be possible to carry out various inter-item correlational studies and factor analytic studies. Such studies may permit us to identify redundant

or non-contributory items. One hopes also to identify clusters of items which reflect such "quality of life" dimensions as social isolations, community involvement, mobility, and family support.

Phase 3, outlined above, has been set for completion by the consortium at April, 1982.

APPLICABILITY: The product of this project will be responsive to the increasing demand for accountability, demand based within federal mandates, third party payers, consumer groups and individual clients.

The product will be relevant to providers of services in meeting the demand, in that present accounting systems are inadequate in justly describing input, process and outcomes of rehabilitation.

062 Quadriceps Pacing, Phase III: Relative Effects of Dynamic And Static Exercise Programs on Maximal Isometric Strength and Motor Unit Synchrony

Principal Investigator:	B.J. deLateur, M.D.	
Status:	Continuing	
Dates:	July 1977-December 1980	
Cost:	Annual \$23,575 RT Annual \$20,125	Projected Total \$42,500 RT % of Annual Total 85%
Annual Report Reference:	#17, Page 491, 8-126	

OBJECTIVES: The first objective is to compare the increase of static strength resulting from different training conditions.

1. a fatiguing task, mixed (dynamic with a hold) versus no exercise
2. a fatiguing task, mixed, versus a nonfatiguing (paced) dynamic task of equal mechanical work
3. a fatiguing task, mixed, versus a fatiguing static task (decay of tension to 80% of initial force)
4. two fatiguing static tasks (decay of tension to 80% of initial force versus decay of tension to 20% of initial force)
5. a fatiguing pure dynamic task versus no exercise
6. a nonfatiguing brief maximal static force versus no exercise

A second objective is to compare the effects of the above types of exercise on the synchrony of motor-unit firing, and to establish whether there is a correlation between the increases in muscle strength with the increases in synchrony.

METHODOLOGY: Thirty-subjects will be randomly selected from a population of healthy, sedentary young adult males. Subjects will be chosen who are not in an active physical training program.

At the beginning of the study and every two weeks thereafter for twelve weeks, the maximal isometric force of each quadriceps will be measured on a strain gauge. Subjects will be divided into six groups of five and will perform the tasks listed above. Since subjects are assigned randomly from a relatively homogenous group, this should eliminate major initial differences between groups. However, the most conservative comparisons are from leg to leg within the groups. These latter will be the principal base for comparison.

The dependent variable in all cases is the rate of change of maximal isometric force and the rate of change in the synchronization ratio. Maximal isometric force on both sides will be measured at 90, 60 and 15° flexion on days 1, 11, 21, 31, 41, 51, 56, 57, 58, 59, and 60. This is every ten days sessions during training and on the final five days when there is no training. Motor unit synchrony will be measured on days 1, 28 and 55 (the beginning, midpoint and end of training).

FINDINGS TO DATE: Thirty-two subjects have completed this study. Dr. Phillip Gollnick demonstrated the needle biopsy technique to the investigators, and funds have been requested to bring Dr. H.S. Milner-Brown to Seattle to talk about the motor-unit firing synchrony. A system whereby the Teca TE-4 electromyograph is connected to an FM tape recorder, so that tape-recorded impulses can be analyzed using Milner-Brown's technique, is being set up.

Paired "T" tests of the test data for the last five days have been done. On these days there were no training tasks, but tests of maximal isometric strength were made, three tests at each of three positions (90, 60, and 15 degrees of the strain gauge arm from horizontal). For each group, the scores of each side on each of the five days were averaged, and tests were done using the five pairs of data. Results are reported in progress report #17.

The number of subjects for this study will be doubled. The new group of subjects will be tested dynamically (in addition to the strain-gauge tests) at various speeds on the recently acquired Cybex isokinetic exerciser, and before and after muscle biopsies and studies of motor unit firing synchrony will be added.

APPLICABILITY: The single largest amount of time in any spinal cord injured patient's rehabilitation program is spent on strengthening exercise, with the intent of giving patients not only strength but also skills they need for their daily living demands.

It is not known whether there is any exercise program with applicability to all the tasks required of spinal cord injured patients. There is evidence in the literature both for some degree of specificity and some degree of interchangeability in exercise programs. Current practice is to prescribe dynamic exercise (high forces or low) as if it were universally applicable. In order for the patient to learn most efficiently to perform given tasks, it would be useful to know how specific a given exercise program is. At the same time training for each and every task would be expensive and time consuming. The information learned from this study will help the physiatrist to prescribe the most effective type of exercise.

063 Functional Distinction Between Neural Systems Involved in the Disabilities of Parkinson's Disease

Principal Investigator:	M.E. Anderson, Ph.D.
Status:	Continuing
Dates:	October 1976-September 1979
Cost:	Annual \$9,775 RT Annual \$9,775
	Projected Total \$25,361 RT % of Annual Total 100%
Annual Report Reference:	#17, Page 400, B-127

OBJECTIVES: To determine the tonic firing pattern of antidromically-identified nigro-striatal and nigro-thalamic neurons during active postural stabilization in awake monkeys. The hypothesis is that nigrothalamic neurons will show a regular tonic firing pattern in this paradigm and that nigrostriatal neurons will show a pattern that is sufficiently distinct such that they can be identified on the basis of this pattern.

METHODOLOGY: Juvenile monkeys (M.mulatta or M.fascicularis) will be trained to maintain a stable head position, in which a light beam from an overhead source is reflected by a skull-mounted dental mirror into an overhead photo-detector cell. Maintenance of this position for the required number of seconds results in delivery of an applesauce reward from a tube mounted in front of the animal, and colored signal lights and presence or absence of a tone indicate "on" vs. "off" position to the animal. The animal's food intake outside the training time is reduced during initial training, but he is not allowed to go below 80% initial body weight at any time, and after initial training, is fed enough to insure a normal growth rate for these immature animals.

At a later time, using a technique adopted by others (D. Bowden, E. Fetz) at the Regional Primate Center and satisfactorily tried by us in one preliminary monkey, stimulating electrodes can be positioned in an awake, behaving animal during recording from the structure under study. This kind of arrangement will be used to allow optimum positioning of electrodes for antidromic excitation of thalamic-projecting nigral neurons from VAmc and VLm, and of nigrostriatal fibers, as they course dorsolaterally in the vicinity of the sub-thalamic nucleus and along the medial border of the internal globus pallidus.

The activity of single neurons in the substantia nigra will be recorded with electrolytically-sharpened tungsten electrodes, insulated except at the tips, which are covered with electrolytically deposited iron particles to improve recording characteristics. The recording electrode is back-fed into a sterile hypodermic cannula, which is inserted through a calibrated R-O adapter.

penetrates the silastic and dura, and extends to a position approximately 5-8mm. above the substantia nigra. The electrode is advanced through the cannula with a hydraulic micromanipulator, and the tonic activity of all isolatable units expected to be in the vicinity of the substantia nigra is recorded. Following acquisition of data during 1-2 minutes of stable, on-target behavior, a unit will be tested for antidromic activation from each of the stimulating electrodes described above. Criteria for antidromic activation will be:

- (1) ability to respond faithfully to each stimulus in a train of 5 stimuli delivered at 500/sec.
- (2) constant latency, using just supra-threshold stimulus intensities, and
- (3) collision with "spontaneous" action potentials, such that failures will occur if the time between the "spontaneous" potential and the stimulus is less than the evoked potential latency plus the refractory period. Threshold stimulus intensities will be determined for each electrode and used to assess the probability of stimulus spread to the other (nigrothalamic or nigrostriatal) system.

Amplified neuronal activity, the output of a stimulus intensity monitor, and logic pulses indicating feeder delivery and "on" vs. "off" head position will be recorded on tape with an Ampex 1800 L analog record. Small electrolytic lesions and deposits of the plated iron particles will be made at known electrode tip depths relative to the tip of the microdrive adapter in several tracks, to allow later reconstruction of recording positions for all neurons.

Following experimental procedures, animals will be anesthetized deeply with sodium pentobarbital and perfused with saline and formalin. The brain will be removed and fixed, frozen sections will be cut and stained with cresyl violet and with potassium ferrocyanide to elicit the Prussian blue reaction with the deposited iron particles. Recording positions will be reconstructed by reference to identified lesion-iron marks made at known positions and mapped on a standardized set of sections.

Firing patterns of neurons will be described in terms of interspike interval analysis done off-line with taped data using existing programs for the Honeywell DDP 516 computer.

This study will require 2-4 monkeys, depending on whether or not data can be collected bilaterally.

FINDINGS TO DATE: Data were collected from a final animal, in which we successfully fired 22 nigral neurons antidromically from stimulating electrodes implanted in the thalamus or laterally in the lenticular nucleus. The latter should have been in the course of nigrostriatal neurons. Cells with regular, high frequency discharge patterns in the alert animal maintaining a stable posture consistently were activated antidromically from the thalamus. Most activated from the lenticular stimulus position had an irregular discharge pattern, with a mean discharge rate under 5 spikes per sec. These data are consistent with earlier hypothesis that nigrothalamic neurons would have high frequency tonic discharge patterns similar to those reported earlier for pallidothalamic neurons, and that the nigrostriatal cells (dopaminergic?) would be characterized by a different type of discharge pattern.

APPLICABILITY: Parkinsonian patients would benefit from therapy based on an improved understanding of how the basal ganglia operate in assuring appropriate motor control.

064 Modification of Speech Patterns of Normal and Dysarthric Speakers as a Function of Four Rate Control Strategies

Principal Investigator:	D.R. Beukelman, Ph.D.	
Status:	Continuing	
Dates:	December 1976-June 1980	
Cost:	Annual \$6,497 RT Annual \$6,497	Projected Total \$22,224 RT % of Annual Total 100%
Annual Report Reference:	#17, Page 276, R-128	

OBJECTIVES: The objectives of this study are to determine the durational, intonational, and stress pattern changes of normal and dysarthric speakers, who are instructed to control their speaking rate through four strategies (1) external pace stimulus provided by the experimenter (2) concurrent external pace stimulus provided by the speaker (3) momentary pause between each word and (4) completion of an utterance within an allotted time. The relationship between speech intelligibility of dysarthric speakers and rate control strategies will be studied.

METHODOLOGY:

1. Normal adult speakers and dysarthric speakers, who speak with less than normal intelligibility, will be included in this study. Ten normal speakers will be included in the first phase of the study, and twenty dysarthric speakers in the categories of ataxic dysarthria and hypokinetic dysarthria will be included in the second phase of the study.
2. During the first phase of the study each speaker will be audio recorded as he produces four sample sentences under one control and four experimental conditions. During the control recording session the speakers will be instructed to read sentences in their habitual conversational manner. The criterion rates under each experimental task will be 60 words per minute, 100 words per minute, and 140 words per minute. During each of the experimental recording sessions, the speakers will be instructed to control their rate according to one of the specific rate control strategies listed under the objective section of this proposal. (1) **External pace stimulus** (2) **Concurrent external pace stimulus provided by the experimenter** (3) **Momentary Pause** (4) **Time Allotment**. Speakers will be permitted to practice various speaking rates with material other than the target material of the study. When they are speaking at criterion rates, the target sentences will be presented and recorded. Each of the four experimental recording sessions will occur on a different day, so that the learning effects on the speaking performance of the subjects will be reduced. The order of the speaking rates under each experimental conditions will be randomly selected. Speech samples will be selected such that each potentially will include a unique stress or intonation pattern. Stress and intonation patterns planned are (1) primary stress first word of sentence (2) primary stress last word of sentence (3) sharp raising intonation last word of sentence and (4) gradual rising intonational pattern throughout the sentence. All speech samples will be recorded on an audio tape recorder, with the microphone placed 10" anterior to the lips of each speaker. The primary acoustic analysis will be completed by an experimental program on a PDP 11 computer. This program simultaneously analyzes fundamental frequency (pitch), intensity (loudness), and the durational aspects of speech and silence during an utterance. From these data the following observations will be taken. (1) Speaking rate, (2) percentage of total utterance time given to pauses, (3) percentage of total utterance time given to

FINDINGS TO DATE: Data have been collected from ten normal speakers. These data have been analyzed in a reliable manner and the software problems in the computer system used to analyze fundamental frequency (pitch) and intensity (loudness), which plagued this project during the first year, have been resolved. The data from the normal speakers have been analyzed and composite performance profiles for the ten normal speakers are currently being developed. These profiles will be used as a "norm" against which the performance of the dysarthric speakers will be compared.

Data have been collected from six ataxic dysarthric speakers and three hypokinetic dysarthric speakers. These data are currently being computer analyzed, so that the performance of these individuals can be compared to the normal profile. An extension until June 1980 will be needed to complete the project.

APPLICABILITY: The treatment plan of most dysarthric patients include a modification of speech rate, although many authors recommend that the speech rate of certain dysarthric speakers be reduced, and some authors suggest strategies to achieve this purpose. Information about the effectiveness of this strategy has not been determined. The information gathered in this study will be used extensively to select treatment strategies designed to modify the speaking rate of dysarthric speakers.

065 Respiratory Function of Quadriplegic Individuals: Influenced by Glossopharyngeal Breathing Training and Periodic Long-Term Follow-Up

Principal Investigator:	R. Berni, R.N., M.N.	
Status:	Continuing	
Dates:	December 1976-December 1979	
Cost:	Annual: \$9,775 RT Annual \$8,625	Projected Total \$21,000 RT % of Annual Total 88%
Annual Report Reference:	#17, Page 283, R-130	

OBJECTIVES:

1. To compare assisted (with GPB) and unassisted vital capacity measurements generated by quadriplegic patient spinal cord injuries at C4-5, C5-6 and C6-7 respectively.
2. To compare change in unassisted vital capacity measurements which occur as one group of quadriplegic patients receives GPB treatment and another group of quadriplegic patients receives no treatment.
3. To compare assisted and unassisted vital capacity measures taken during long-term follow-up.
4. To describe personal respiratory maintenance program after discharge.

METHODOLOGY: All subjects included in this study will be classified as quadriplegic due to functionally complete cervical cord lesions. No subject with known respiratory impairment other than related to quadriplegia will be included. 20 subjects will be included in Group 1 — GPB treatment and 20 subjects will be included in Group 2 — non-GPB treatment¹ will be matched according to a) sex b) time since onset c) age and d) height.

GPB treatment will be delivered once daily for 20 minutes to subjects included in Group 1. Assisted vital capacity measurements and unassisted vital capacity measurements (the maximum measurement during 3 trials) will be taken once weekly from the patients in the treatment group. Unassisted vital capacity measurements will be taken once weekly from the control group. All measurements will be taken in the supine position, since data collection will begin before some of the subjects are able to sit. Glossopharyngeal breathing treatment will be terminated for subjects

FINDINGS TO DATE: Twenty quadriplegic persons have completed the glossopharyngeal breathing treatment program and the inpatient data have been completely collected from these subjects.

The patients are difficult to find in the outpatient phase, but progress is being made and the data will be summarized and reported in 1980.

APPLICABILITY: The results of this study will assist members of the rehabilitation team as they seek and select training procedures designated to increase respiratory capacity of quadriplegic patients with various time of onset and various lesion levels.

Expected consumers' use of findings:

- a. Better respiratory maintenance.
- b. Better overall body system function.
- c. Better potential for employment.
- d. Better opportunity to prevent physiological and psychological deterioration and increased cost to the consumer or the taxpayer.

066 Measurement of Musculature Blood Flow Induced by Microwave Diathermy

Principal Investigator:	J.F. Lehmann, M.D.	
Status:	Continuing	
Dates:	August 1976-August 1980	
Cost:	Annual N/A RT Annual N/A	Projected Total N/A RT % of Annual Total N/A
Annual Report Reference:	#17, Page 109, R-131	

OBJECTIVES: To ascertain the quantitative relationship between doses of microwave diathermy and deep musculature blood flow increase and rate change.

METHODOLOGY: The utilization of clearance rate of radioisotopes from tissue beds as an index of their blood flow has long been done both clinically and experimentally. In the present study the wash-out of injected Xe^{133} a method particularly useful in the measurement of skeletal muscle blood flow 2, 3, 4, 5, will be employed using the human thigh for the diathermy paradigm. The geometrical dispersion of the injected Xe^{133} depot will be imaged by means of a gamma ray camera interfaced with an on-line computer having disk memory allowing replay of the depot clearance event and separate analysis of different regions of interest in time and space. The wash-out image coupled with the measurement of the radioactive clearance by means of scintillation counter will give a quantitative picture of the thigh blood perfusion rated. In addition,

the microwave diathermy process comprising both the absorbed energy distribution and the responding blood flow field will be modeled with a finite element digital computer thermal analyzer[®] to define the range of most probable models describing the physiologic response of the thigh to this process. This computer model will consolidate information from a) previous and ongoing tissue substitute model energy deposition experiments, b) transient human thigh temperature data obtained *in vivo* during diathermy application, c) anatomical details regarding the thigh's geometrical distortion under the weight of the direct contact diathermy applicator; those details obtained from cadaver thigh specimens and d) the aforementioned Xenon blood clearance experiments.

I. Xe^{133} CLEARANCE EXPERIMENTAL PROCEDURES

A. Preliminary Sessions:

Prior to the actual isotope wash-out experiments, the experimental subjects are to be familiarized with the general procedures to be followed during the experiments. In addition, X-rays of both thighs from the lateral aspect will be taken to determine the anatomical dimensions relevant to the thigh diathermy problem; i.e. thickness of the anterior layer of fat, location of the femur relative to the anterior thigh surface and the distortion of the thigh profile (again due to the weight of the diathermy applicator and the seated posture of the subject) are to be measured. This session will last approximately 30 minutes per subject.

B. Blood Flow Experiments:

The blood flow measurements will be performed under a variety of conditions and as such the overall study is divided into the following eight experiments. Each injection of the isotopic Xenon solution (Saline and Xe^{133}) will be performed with a very fine hypodermic needle (27-31 gauge) and the volume will, in each case, be 0.1 ml, with a radioactivity (specific activity) of approximately 1 millicurie per cc. All measurement sessions will be preceded by a rest period in which the subject will be recumbent and rested comfortably for a period of 30 minutes.

Exp. 1. Preliminary Xe^{133} Washout Measurements

Injection of the radioisotope will be performed at a depth of 1.5 cm in the upper third of the anterior aspect of both resting thighs with the subject supine. Both legs will be monitored for isotope wash-out, one by gamma camera and the other by scintillation probe. The wash-out decrement (Slope of the log-plotted count rate vs. time) of these instruments will yield the local value of blood flow rate at the respective sites of injection. The clearance rate will be monitored to determine the time period over which a significant gamma ray count can be detected (not to exceed one hour). One or two deeper injection depots will also be employed in identical experiments to ascertain the effect of tissue attenuation on the maximum useful (i.e. measureable) wash-out period.

Exp. 2. Xe^{133} Washout with Diathermy Heating and Air Cooling

This experiment is identical to the preceding Exp. 1 with the following exception: after approximately 15 minutes of imaging/counting the thigh under the camera will be cooled for five minutes (with the camera removed) with an air-cooled direct contact diathermy applicator and subsequently heated with this device (with concurrent cooling) for 20 to 30 minutes or until such time that subject discomfort warrants cessation of heating. Immediately after this diathermy application the gamma camera will be repositioned over the thigh and the wash-out site monitored for blood flow as long as it remains measureable. The opposite thigh will be continuously and simultaneously observed by scintillation probe during the entire experiment to provide a control measurement as well as an opportunity to study the contralateral perfusion effects of diathermy performed on the opposite limb.

Exp. 3. Washout with Diathermy Heating Only

This part is identical to the methods used in Exp. 2 except that no pre-cooling or cooling during diathermy application will be done.

Exp. 4. Washout with Cooling Only

This experiment is identical to Exp. 2 except that there will be no heating phase.

Exp. 5. Simultaneous Measurement of Blood Flow and Tissue Temperatures

The *in vivo* measurement of the temperature distribution in a subject's thigh will be done by means of temperature sensors (thermistors) mounted on the tips of long thin hypodermic needles which will be inserted laterally into the thigh such that the sensors underlie the centerline of the diathermy

applicator at varying depths in the tissue. Four to six of these sensors will be positioned with the aid of X-ray examination so that the sites of temperature measurement are known. All such experiments employing invasive temperature probes involve the implantation of such probes in only one thigh of each subject. Prior to insertion of these temperature probes Xe^{133} solution depots will be injected in both thighs as described in Exp. 1; the subsequent wash-out will be measured periodically to determine the effect of the probes on the thigh blood perfusion field.

Exp. 6 Blood Flow and Temperature Measurement with Diathermy Heating and Cooling

This experiment employs the methods described in parts 2 and 5 concurrently in order to gauge the effect of diathermy heating and cooling on the simultaneous blood flow and temperature fields underlying the diathermy applicator. This method will provide a significant advantage over the previous experiments in that the observed temperature levels will provide a means by which the scintillation counter(s) can be positioned for wash-out determinations at moments of particular interest in the diathermic blood flow response; for example, at the moment of peak flow. This method will also provide a means of investigating whether or not the microwave diathermy process can be utilized to override the cooling effect of augmented blood flow and thereby establish the feasibility of controlling the tissue temperatures such that they are maintained in the "therapeutic range."

Exp. 7 Blood Flow and Temperature Measurement with Heating Only

The methods of Exp.'s 3 and 5 will be combined to study the effect of heating only on temperature and perfusion rates.

Exp. 8 Blood Flow and Temperature Measurement with Cooling Only

The methods of Exp.'s 4 and 5 will be combined to study the effect of cooling on temperature and perfusion rates.

II. INSTRUMENTATION AND MATERIALS

- A. A dual probe, NaI crystal scintillation counter will be used to measure tissue gamma ray emission levels which are proportional to the concentration of Xe^{133} at the injection depot. These measurements yield local blood flow rates.
- B. A high resolution, circular field gamma ray camera and companion imaging system will be used to image and count XE^{133} wash-out in the thigh. This system is connected to a disk memory on-line computer as previously described.
- C. A 915 Mhz air-cooled direct contact diathermy applicator that has been designed and tested in our laboratory will be used to heat the thigh. A 915 Mhz General Electric Magnation has been adapted to allow the operator to vary the output microwave power level from 5 to 100 Watts. The power level used in the experiments will be approximately 40 Watts net. The direct contact applicator has a cold air supply/pump system that permits the operator to select and maintain the desired temperature and flow rate of cooling air. This air system is also instrumented to continuously show the relative humidity of the air stream.
- D. A CDC 6400 Digital Computing System and a heat transfer thermal analyzer program developed in conjunction with the University of Washington Department of Mechanical Engineering, will be employed in the computer modeling of the thigh diathermy process.
- E. Radioisotope: Xenon 133, a very weak-emitting, low energy (gamma ray) radioisotope which has been safely and routinely used for years in clinical and experimental blood flow and volume measurements will be injected in saline solution at specific activity levels of approximately 1 millicurie/cc. It will be injected into the quadriceps through very thin (27-31 gauge) hypodermic needles, too small to cause significant bleeding. The half-life of this isotope is 5 1/2 days, though the Xe^{133} expelled from the body in a matter of minutes through the lungs.

FINDINGS TO DATE:

1. The rigorous determination of the synthetic tissue thermal properties have been reported in the literature and have been utilized in new energy deposition experiments whose results have also been reported.
2. All of the diathermy/ Xe^{133} washout experiments not involving simultaneous measurement of muscle temperatures have been completed. Specifically, this portion of the study comprised of 44

separate Xe^{133} washout experiments performed on 13 healthy volunteer subjects (11 male, 2 female) in 25 separate experimental sessions. All anterior thigh injections were placed in the belly of the rectus femoris muscle at depths of either 1.5 or 3.0 cm below the skin surface. To provide control values most experiments involved simultaneous measurement of both thighs; the imaging experiments were performed at 3.0 cm depth as well as the 1.5 cm depth proposed in exp. 1, part I, B of section 8.

The imaging experiments established the uniformity of the Xe^{133} tracer deposition and its washout, as well as the small (0.85 - 1.15 cm in diameter) and unchanging size of the injection depot. These findings lend support to the method of Xe^{133} clearance as a suitable technique for achieving a sufficiently localized blood flow measurement. The average RBF determined from measurements in 28 thighs (2.6 ml/min/100 gm) is equivalent to those found by other investigators under similar conditions. Microwave heating for 10 minutes at moderate power (33 watts net) without cooling showed that a tenfold increase in blood flow may be attained at 1.5 cm depth, and yet with cooling the perfusion level is suppressed to a fraction of this increase. Specifically, for five minutes of cooling with 5°C air at a flow rate of 20 cubic ft/min, a mean post-cooling MBF decrease was found of 62% and 29% for perfusion at 1.5 and 3.0 cm depths respectively.

The maximum measured MBF response to heating (≈ 32 ml/min/100 gm) occurred at 3.0 cm depth and is comparable to peak values in the literature reported for reactive hyperemia in skeletal muscle. With the use of surface cooling the blood flow field appears to parallel the thigh temperature field in that a gradient of blood flow is established.

The data accentuates the ability of this particular diathermy device to "focus" perfusion as well as temperature into the muscle bed, thus providing a means for concentrating the therapeutic effects deep into the tissue while simultaneously maintaining safe superficial temperatures.

3. The diathermic blood flow experiments involving simultaneous temperature measurement have been initiated. Two major equipment systems have been developed and tested: (a) a new diathermy/air cooling unit which incorporates a much-improved system of cold air delivery capable of delivering cold air from 0 - 100 cfm at temperatures ranging from 0°C to room temperature with a stability of $\pm 0.1^\circ\text{C}$ and includes the ability to measure the humidity of the treatment air stream; (b) a temperature measurement system which includes: (1) special thermistor probes with "microwave transparent" electronic circuitry designed to minimize microwave-induced artifacts often associated with these types of measurements, (2) a signal multiplexer permitting 10 channels of temperature information to be handled simultaneously, and (3) a dual-pen strip chart recorder matched to the multiplexer.

The effect of presence of the temperature probe on blood flow field has been tested. It has been found that time needed for the hyperemic response to the injection and temperature probe insult to stabilize to resting (RBF) levels is not significantly different from that of the Xenon injection alone. Thus a primary anticipated difficulty as regards these measurements has been obviated. Based on results of three human experiments incorporating cooling and diathermy heating effects, there appears to be a definite tissue temperature threshold in the neighborhood of 42°C which, when initially exceeded, triggers a prolonged heat-induced hyperemic blood flow response of a magnitude in accordance with the responses typified by the post-treatment curve.

The simulation of these diathermic processes on the CDC 6400 digital computer utilizing the two-dimensional, finite element thermal analysis program, has produced good agreement between thigh temperature behavior found in human experiments and that of the model when a variable gain MBF response to microwave heating was employed. This type of model, may prove to be the most useful description of the muscle blood flow response to heating. Its general applicability must be confirmed or denied by data yet to be obtained from further tests.

APPLICABILITY: The information that will be obtained can be used by engineers to design improved applicators, to test their designs and also by physiatrists and physical therapists to prescribe and carry out more effective diathermy treatments.

**067 Determination of Basal Ganglia Influences on Other CNS Motor Systems:
Development of a Model in which Therapeutic Procedures can be Tested**

Principal Investigator:	M.E. Anderson, Ph.D.	
Status:	Continuing	
Dates:	October 1977-September 1979	
Cost:	Annual \$15,812 RT Annual \$15,812	Projected Total \$11,380 RT % of Annual 100%
Annual Report Reference:	#17, Page 408, R-133	

OBJECTIVES: To determine, by carefully-controlled stimulation of the substantia nigra and intracellular and extracellular recording from neurons in the thalamus and superior colliculus, whether the synaptic effect of nigral axons terminating on these cells is excitatory and/or inhibitory.

METHODOLOGY: Cats utilized for these experiments will be anesthetized with sodium pentobarbital, alpha chloralose or halthane and nitrous oxide replaced with nitrous oxide after surgical procedures are completed. Because paralysis and artificial ventilation will be necessary to permit intracellular recording, care will be taken to insure that when only N₂O and O₂ are administered during recording, the arterial blood pressure remains stable and the pupils are slit as indicators of adequate analgesia. In addition, a long-lasting local anesthetic will be injected around stereotaxic pressure points and skin incisions.

Because neurons in the basal ganglia are particularly susceptible to the depressive effects of general anesthetics such as barbituates, a few experiments might be needed on animals without general anesthesia and with extensive, careful infiltration of wound margins and pressure points with long-lasting local anesthetics.

Suction will be used to remove tissue overlying the thalamus or superior colliculus as deep as the corpus callosum or the dorsal hippocampus. Recording microelectrodes filled with potassium citrate or potassium acetate saturated with fast green will be introduced stereotaxically into the thalamus or superior colliculus to allow intracellular and extracellular recording from neurons in these structures. Usual procedures, such as pneumothorax, will be done to improve stability.

A stimulating array of 6-9 tungsten electrodes, sharpened electrolytically and insulated to within 0.5 mm of the tips, will be introduced into the substantia nigra and surrounding structures from an angle to avoid mechanical interference with recording electrodes in the ipsilateral superior colliculus (Yoshida, Rabin, and Anderson 1971, 1972). Stimulating electrodes also will be positioned caudally in the contralateral medial longitudinal fasciculus (MLF) so that we can determine whether the neurons studied can be activated antidromically from MLF levels at about midpons, where the axons of many collicular efferent neurons would be situated (Altman and Carpenter, 1961; Anderson, Yoshida and Wilson, 1971).

Intracellular recordings of postsynaptic potentials evoked by bipolar stimulation between adjacent electrodes will be taken and threshold stimulus intensities will be determined. The array will include control electrodes situated deep and superficial to the substantia nigra, and to further separate out any responses due to stimulus spread to non-nigral structures, stimulating electrode arrays will be moved with micromanipulators and stimulus threshold intensities for evoked responses will be measured in several neurons with the stimulating array at each stimulus depth to determine points of lowest stimulus threshold. If the data are ambiguous because of possible effects due to stimulus spread, especially to the medial lemnisci that lie just dorsolateral to the substantia nigra at some levels and to the cerebral peduncle just ventral to SN, it may be necessary in some animals to interrupt the pyramidal tract and medial lemniscus fibers ipsilateral to planned SN stimulation early enough to allow them to degenerate before the acute experiments.

Intracellularly-recorded data will be supplemented by extracellular records, examining stimulus evoked effects on spontaneous activity or in a conditioning testing format in which the cells response to a test stimulus such as a shock to the contralateral forepaw or to neck muscle nerves is evaluated when it is applied at various intervals relative to a conditioning stimulus to the substantia nigra.

University of Washington

Intracellularly and extracellularly-recorded potentials will be amplified by conventional techniques, photographed with kymograph film, and recorded on FM tape (Ampex 1800L; frequency range DC-5kHz). Averaging and peristimulus time histograms can both be done using existing programs for the Honeywell DDP 516 computer.

Recording sites will be determined by reference to spots made by fast green FCF deposited electrophoretically from the recording electrodes. Stimulus positions will be marked by electrolytic lesions. At the termination of the experiment, the brains will be perfused and fixed in formalin and recording and stimulating positions will be determined from frozen sections. The distribution of responses evoked from different stimulus positions will also be mapped for the superior colliculus.

About 20 cats will be needed for these studies.

FINDINGS TO DATE: Identification of branching nigrothalamic and nigrocollicular neurons and identification of pallidal afferents by horseradish peroxidase retrograde transport have been completed. Investigators are in the final phase of the experimental work.

It has been demonstrated that a significant proportion (greater than 40 percent) of the neurons in the substantia send axonal branches to both the substantia nigra and to the thalamus, and data from collision techniques has been used to show that the branch point for most neurons must be rather near the axon's origin at the soma. There seems to be no relative segregation within the nigra of neurons projecting to the thalamus and colliculus.

Having shown that neurons in the pedunculopontine nucleus (PPN) of the tegmentum are retrogradely labeled by horseradish peroxidase injected into the globus pallidus of the monkey, this has also been true for the cat, the response of cat pallidal neurons following electrical stimulation of the pedunculopontine nucleus have been recorded. Stimulation does produce excitation of pallidal neurons, but from extracellular recordings, it is difficult to determine if this is produced monosynaptically. Currently, researchers are recording intracellularly, and data collected thus far show EPSPs following pedunculopontine stimulation that appear to be produced monosynaptically. It has been determined that the lowest threshold stimulus points for exciting pallidal cells by PPN stimulation correspond to the area where we found labeled neurons following horseradish peroxidase injection in the globus pallidus. Thus, data are consistent with the hypothesis that PPN provides an excitatory input to basal ganglia output neurons, and this probably occurs via a direct projection.

APPLICABILITY: Involuntary movement disorders, such as cerebral palsy and other choreoathetoid dyskinesias are a national problem with a large population currently not independent or employable. For example, cerebral palsy has an incidence of about 6 per 1,000. Rational approaches to therapeutic management of these disorders is hampered by our lack of knowledge regarding the relationship of the basal ganglia to subsequent neural "motor systems." The description of the "wiring diagram" for these systems would allow us to test pharmacological and other therapeutic methods for modifying or compensating for dysfunction in these systems.

068 Evaluation of a Circular Polarized Microwave Diathermy Applicator

Principal Investigator:	J.F. Lehmann, M.D.	
Status:	Continuing	
Dates:	June 1977-June 1980	
Cost:	Annual \$15,167 RT Annual \$9,992	Projected Total \$53,496 RT % of Annual Total 65%
Annual Report Reference:	#17, Page 126, R-134	

OBJECTIVES: To evaluate a recently designed diathermy machine which selectively heats muscle and joints covered with minimal amounts of soft tissue which will be compatible with federal safety regulations as set forth by the Bureau of Radiological Health.

METHODOLOGY: A circular waveguide aperture-type applicator operating at a frequency of 915 MHz has been developed for use as a diathermy applicator.

University of Washington

Various tissue substitute models will be constructed using a new fabrication technique which is being developed in a related study (R-135). The models will be irradiated with the circular polarized applicator at high power for short periods of time. Thermograms will be taken and processed by computer to produce thermographs showing the temperature distribution throughout the model. From this data, the rate of absorption of energy (W/kg) in the various tissue layers can be calculated. This will allow the effectiveness of the applicator in heating various types of tissue to be determined. After the energy absorption pattern is determined in the model, human volunteers will be used to determine actual temperature distribution.

FINDINGS TO DATE: Several prototype direct-contact circularly polarized diathermy applicators were evaluated for possible clinical use. Three of them were 915 MHz applicators which were developed in-house:

1. An 11.1 cm diameter 915 MHz applicator.
2. An 11.1 cm diameter, non-homogeneously dielectrically loaded 915 MHz applicator.
3. An 8.9 cm diameter 915 MHz applicator.

At this point in the project, several results are apparent:

1. The three 915 MHz applicators developed in-house were found to produce depths of penetration of 2.6 to 3.0 cm in the planar model. The fat to muscle selective absorption rat (SAR) ratio varied from 0.4 to 0.5.
2. A Transco manufactured 2450 MHz applicator produced a depth of penetration of 1.8 to 2.0 cm in the planar model. Its fat to muscle SAR ratio was found to be 1.0.
3. The 915 MHz applicators produced circularly symmetrical heating patterns in a transverse plane of the planar model. The Transco 2450 MHz applicator produced an elliptical heating pattern.
4. When exposing the thigh-shaped models and the cylindrical model, the 915 MHz applicators were found to produce heating patterns which were independent of applicator orientation. With the Transco 2450 MHz applicator, the heating patterns produced were dependent on applicator orientation.

Currently standards are being established for microwave diathermy which will define effectiveness of the applicator and limits of allowable stray radiation. The data discussed above, and the additional data determined in R-135, will be utilized to define applicator designs which will provide selective absorption in the tissue while producing minimal stray radiation, as well as aid in the setting of standards.

The main clinical advantage of the 915 MHz applicator over the non-contact applicators is the less stray radiation compared with other direct contact applicators. There is no preferential stray radiation increase in the direction of the E field vector as documented in the linearly polarized applicators. The chances of inadvertently exposing sensitive organs are reduced with this applicator as compared with circularly polarized applicators at 2450 MHz (Transco). The potential for deep heating to tolerance level, for instance, in musculature, is markedly enhanced.

At the higher frequency level of 2450, high SAR values were found in subcutaneous fat. This in combination with the low specific heat of the fat produces significantly higher temperatures in the subcutaneous fat. These temperatures may not exceed tolerance level and therefore the temperatures in muscle remain relatively low.

The applicators operating a 915 MHz produce a peak SAR and subsequently the highest temperature in the musculature and thus are more suitable for deep heating purposes.

APPLICABILITY: Diathermy is a type of therapy designed to treat the most severely disabling sequelae of diseases leading to joint contractures. It is also anticipated that this may be of significance in the treatment of such serious disease entities as polymyositis. This treatment procedure is one that could be put into practice in hospitals throughout the United States.

069 Development of New Phantom Materials for Testing Diathermy Applicators

Principal Investigator: J.F. Lehmann, M.D.
Status: Continuing
Dates: July 1977-July 1980
Cost: Annual \$6,382 Projected Total \$44,000
RT Annual \$4,542 RT % of Annual Total 71%
Annual Report Reference: #17, Page 134, R-135

OBJECTIVES: The objective of this project is to develop a new phantom fat tissue, eliminating interface problems, that could be used to test and evaluate any type of diathermy applicator over a large frequency range.

Once these models have been developed they can be built to duplicate certain parts of the body that are frequently exposed to electromagnetic radiation. While these models are being irradiated, power density measurements around the models can be made to determine the amount of stray radiation being produced by various applicators. This is important to know to insure the safety of the patient and operator.

These models would also yield patterns of relative heat so that energy absorption in them could be calculated. The heating patterns would also be used to identify areas of maximal heating which would be used to select the applicator that would heat the area of pathology.

METHODOLOGY: The initial design approach will be the development of a new phantom fat material to be placed at the interface of fat or bone models. This design approach addresses three problems. To eliminate the air gap at the fat interface, the new phantom material must be a compressible solid, (rubber foam or soft epoxy) or a viscous liquid material. Secondly, the material must adhere to the current phantom tissue. Finally, the thermal properties (specific heat) of the two materials should be approximately equivalent.

The electromagnetic properties of the new synthetic fat tissue must be approximately equivalent to the currently used synthetic fat. At a minimum, materials for each of diathermy frequency bandwidths must be developed (i.e. 13.56 MHz, 27.12 MHz, 40.68 MHz, 915 MHz and 2450 MHz). Ideally materials should be developed which could be used for any frequency between 10 MHz and 3 GHz.

When materials with acceptable mechanical and electrical properties have been developed, the modified phantom model must be tested using a thermographic technique developed by Guy. Briefly this procedure involves the following steps. A high power source is connected to a diathermy applicator. The applicator is then used to irradiate the phantom model for a short period of time (10 to 20 sec.). An infrared camera scans the model, recording the heating distribution in the model. Comparisons of theoretical and measured Specific Absorption Rates (SAR's) for several diathermy applicators will be used to verify correct heating in the model. SAR is defined as the rate of energy absorption per unit mass. The peak SAR's in the model should not vary as a function of applicator orientation on the model (i.e. the direction of the electric field vector with respect to the model interface should not affect the SAR in the model). Also, thermograms of heating induced by applicators with irregular field configurations will be made to insure that "hot spotting" is eliminated from the model.

FINDINGS TO DATE: A search has been continued for dielectric materials which would adequately substitute for fat tissue and overcome the discontinuity effects experienced when using split models. Best materials found for 915 and 2450 MHz were hexyl, heptyl and octyl alcohols. At 918 MHz the conductivity of fat tissue ranges from 55.6 to 147, with 66.5 being the median value. Conductivity was used as the criterion for matching, since the dielectric constant is usually low, while the loss tangent is high. Their product (conductivity being a function of the product of the two) is a reasonably good measure of power absorption in the tissue, hence it was chosen as the main criterion.

For 2450 MHz the conductivity of these ranges from 96.4 S/meter to 213 S/meter the median value being 117 S/meter. Hexyl alcohol has a conductivity at 2450 MHz of approximately 119 S/meter, which is the best of three. Octyl alcohol is approximately the same as heptyl alcohol being

approximately 98 S/meter. This will be further verified by using a small square horn as an applicator to evaluate hexyl and octyl alcohols at 2450 MHz.

Thermograms were taken with both octyl alcohol and with heptyl alcohol on the planar model using a two-cm fat layer over a 10-cm muscle layer at 918 MHz using a 13 by 13 cm linear-polarized applicator. The two alcohols produced extremely similar results. However, octyl alcohol is the most convenient to use.

At 27.12 MHz, propylene glycol saturated with NaCl yields a dielectric constant of 30.4, a loss tangent of 0.56, Sigma 25.6. These values are slightly higher than those for the tissue model (20.0, 0.508 and 15.32 respectively) but they agree very well with measurements taken on a fat tissue substitute by the same method. Hence this seems to be a valid material for use at this frequency. As far as direct use as an interface material, an artificial crack was generated in a pair of slab halves, but due to thermograph response and the small effect of the crack, little was seen on the resulting plot. This situation will be investigated more carefully in future work. Because high power is not available at 27.12 MHz, thermograms are not of very high quality (i.e., little can be seen in a short exposure thermogram, and a long exposure would allow temperatures to diffuse, negating the validity of the plot). More power may be available in the future since a technique of matching the 50-ohm source more completely to various loads has resulted in delivering more power to the applicator.

APPLICABILITY: The development of the new phantom material will allow us to develop and test new diathermy applicators that can heat specific areas that need treatment and will also be safe to patient and operator by having the least amount of stray radiation.

070 Quantification of Biomechanical Function of Ankle-Foot Orthoses in Hemiplegia

Principal Investigator:	J.F. Lehmann, M.D.	
Status:	Continuing	
Dates:	December 1977-July 1980	
Cost:	Annual \$16,560 RT Annual \$12,650	Projected Total \$34,000 RT % of Annual Total 76%
Annual Report Reference:	#17, Page 158, R-136	

OBJECTIVES: To evaluate the biomechanics of ankle-foot orthoses and their effect on the gait of persons with upper motor neuron paralysis and/or hemiplegia. The first phase of the evaluation will measure the moments and forces required to maintain the paralyzed foot and ankle in a functional position throughout the gait cycle. The second phase will determine the effect of these forces on knee stability throughout the gait cycle by measuring the moments developed around the knee. This will allow us to establish design parameters for ankle-foot orthoses and to relate these to the function provided by orthoses currently manufactured. With this information, a method may be developed to prescribe orthoses according to a discrete set of quantitative criteria.

METHODOLOGY: We will measure the ground reactive forces, the forces carried in the orthoses and the kinematics of the gait cycle. All of these variables will be measured through the entire gait cycle, i.e. from heel strike to heel strike. The ground forces will be measured by a force platform which is standard equipment in our laboratory. This system measures the orthogonal components of force applied to it, from which the location and magnitude of the force vector leaving the platform can be calculated. The forces in the orthoses will be determined using strain gauge transducers to measure the moments in the uprights throughout the gait cycle. The kinematic data will be measured by using a 35 mm motion picture camera to record the position of the limb in space, with markers identifying the axis of rotation of the knee and specific locations of the foot. These spatial data will be synchronized with measurements of the ground reactive forces and the moments in the orthoses. Kinematic data will also include stride length, cadence and phase of gait. Flexion angle of the knee is also recorded.

With the ground reactive force data and the kinematic data, the total moments in the leg and orthosis can be calculated. Then, by subtracting the moments measured in the orthoses from the total moments, the moments in the limb can be calculated. In addition, using the vector calculated from the ground reactive forces and the kinematic data describing the position of the knee axis, the flexion-extension moments at the knee can be calculated. Other measurements such as stride length, cadence and phase of gait are used as control variables.

The measurements described will be made on ten hemiplegic patients with varying degrees of spasticity. We will determine the ranges of force necessary to maintain the patient's foot in function positions during the stance and swing phase. We will then apply an orthosis which provides only the force defined in the measurement re-evaluate his gait for knee stability and specific kinematics.

FINDINGS TO DATE: The first series of experiments with hemiplegic patients has been concluded to measure the moments created in the upright metal orthosis by the patient. Measurements included plantar flexion, dorsiflexion and inversion and eversion moments. These measurements may be used for design criteria for orthoses or to decide if a given orthosis can withstand various degrees of spasticity, equinus deformity and inversion. The orthosis should be just strong enough to function properly but not unduly heavy. Further statistical analysis of these quantitative data will be necessary.

In order to study orthotic designs using plastic materials it was felt that a different methodology would have to be developed. After various trials to obtain force or moment measurements in these orthoses, it was decided to compare these orthoses by measuring any mobility which the orthosis allows by electrogoniometry.

All commonly used plastic ankle foot orthoses including plastic laminates (Seattle orthosis), the same design using heat-forming polyethylene (Rancho orthosis), the Engen orthosis and the Teufel orthosis, were used with various trim lines and adjustments. Total data evaluation has been completed for a limited number of normals and patients. Further data processing will be necessary and a thorough analysis of the data is in progress. Preliminary visual evaluation of the various curves plotted out by the computerized system suggests that patients with different conditions, differing levels of spasticity and other problems can be best accommodated by different types or modifications of orthoses. It is anticipated that once the fully detailed evaluation can be accomplished, more specific indications matching the patient need to specific orthosis with a specific trim line will be the result of this study. Thus a more or less quantitative evaluation and prescription of the orthosis may be possible.

APPLICABILITY: The ability of the hemiplegic patient to walk can most significantly alter his ability to integrate into the community. This study aims at the development of a more sophisticated approach to bracing the patient. By quantification of the loss of function as well as the degree of function which is restored by various designs of orthoses, the needs of each hemiplegic patient can be met more selectively, and the danger of over or underbracing the patient will be lessened.

A large segment of the population would be affected, since the information would apply not only to the 2 million stroke victims but also to other patients with upper motor neuron lesions.

071 Investigation of Predictors of Change or Treatment Progress in a Behaviorally-Based Treatment Program for Selected Cases of Chronic Pain

Principal Investigator:	W.E. Fordyce, Ph.D.	
Status:	Continuing	
Dates:	July 1977-October 1980	
Cost:	Annual \$19,950 RT Annual \$4,750	Projected Total \$60,000 RT % of Annual Total 29%
Annual Report Reference:	#17, Page 223, R-139	

OBJECTIVES: Among patients identified as having significant amounts of operant pain and selected for a

behavioral-based treatment program:

to assess relationships among a series of measures of change in patient performance or activity level at the beginning and end of treatment and at selected followup points;

assess relationship between medical descriptive data, MMPI scores and pretreatment activity baseline measures, on the one hand, and amounts of change and durability of change through followup, on the other, in order to identify predictors of amounts of treatment gains;

assess changes between pre- and post-treatment estimates of health care utilization costs.

METHODOLOGY:

Subjects: The population studied will be persons with chronic pain problems who have been accepted for treatment in the operant pain treatment program on the Physical Medicine and Rehabilitation Service. These are persons 20-70 years of age who have a chronic pain problem of at least six months' duration which interferes significantly with their functional activity level. In addition, these patients have a significant component of operant pain; i.e., there is a learning component to the pain problem - as evaluated by a psychologist experienced in the evaluation of operant pain, as well as one or more physicians experienced in evaluating pain problems.

Materials: The Pain Data Protocol, Activity Diaries, physician evaluation data, and the Minnesota Multiphasic Personality Inventory (MMPI), and daily records of physical and occupational therapy activities will be used.

Procedure: Patients who are selected as potential participants in the Operant Program are brought into the hospital on the Physical Medicine and Rehabilitation Service. For 7-10 days there is a "baseline" period where baseline levels are taken for activity in physical and occupational therapy and, if necessary, there may be further evaluation of the pain problem. During this period patients will be given their usual medication on an "as needed" basis, with records kept of amount given and time pattern usage. At the end of the baseline period a treatment program will be drawn up, the program will be explained to the patient and his/her significant family member or friend, and, if accepted by the patient and friend, treatment will begin.

The inpatient treatment phase generally lasts 6-8 weeks, during which the patient participates in physical and occupational therapy activities which start out in small amounts and increase daily, vocational counseling and job station activities, programmed recreational activity, sessions with psychologists. Medication is put into "cocktail" form; i.e., put into a cherry syrup vehicle is given on time-contingent basis, and amount of medication in the vehicle is gradually reduced. Patients are positively reinforced for increased activity for recreation activities, for socialization. Pain complaints and nonverbal indications of pain are given neutral responses.

At the end of the inpatient phase, a one-to-two week outpatient program goes into effect. The patient initially maintains his/her inpatient schedule but lives outside the hospital and comes in daily. This is gradually generalized to include more away from the hospital activities.

Data during treatment will be collected as follows. Activity diaries will be completed by the patient daily and collected weekly throughout the inpatient and outpatient phases of the program. Physical and occupational therapy activities will be recorded at each session and records will be kept. An MMPI will be completed by the patient at discharge.

Follow-up data will be collected at three months, six months, one year and two years post-discharge. At three months', one-year and two-year follow-up, a week of activity diaries will be completed by the patient, and the follow-up section of the Pain Data Protocol will be administered to the patient (including data on health care utilization, income, activities). At those times, the Social/Leisure Form and a brief questionnaire recording vocational or employment status will also be completed.

Data Analysis: The continuous score variables can be assessed by correlational analysis.

Variables yielding non-continuous data are likely to require non-parametric methods for analysis. The precise methods to be used will in turn be influenced by the size of the "n" and by sex distribution considerations. Statistical consultation will be drawn upon to assist in selecting the most appropriate methods for analysis of those data.

Such items as number of hospitalizations, number of surgeries, number of physician contacts, will require non-parametric item tally comparisons. Other measures such as days in hospital and

dollars for medications, and dollar measures derived from estimates of costs of the various health care utilization activities can be analyzed by simple t tests, comparing pre- with post-treatment data.

FINDINGS TO DATE: This project began in 1977 and significant progress was made until a curtailment of funds in October 1978 necessitated temporary interruption of data accumulation. While the clinical process proceeded, none of the data essential to the project could be accumulated. Data collection was resumed in April 1979, and is currently underway.

In view of the gap in data and the two-year follow-up provision, it would appear prudent to extend the completion date to October 1980 to gather sufficient data to permit assessment of the questions addressed by the study.

In the period since the last report, the following data have been collected: 8 six-month follow-up sets; 8 one-year follow-up sets; 6 two-year follow-up sets; and 4 intake data sets.

APPLICABILITY: Reference has been made to the Clowers survey showing that 13% of new DVR clients in the State-Federal program of Region X of DHEW are identified as having the disability of chronic low back pain. That figure alone establishes direct relevance to rehabilitation.

Patients treated in this program in the past have averaged 7 years since onset and 2.7 major surgeries for their referring pain problem (Fordyce et al. 1973). All patients treated have undergone multiple treatment programs prior to entering the operant program. Clearly, the more conventional treatment approaches have failed to solve the problem or the patient would not come for help. This means that a significant percentage of the labor force, and of vocational rehabilitation case rolls, include workers for whom treatment is failing to resolve their pain problems. The success of the behavioral approach and its rapidly expanding application throughout the country, support the inference that this project has direct relevance to rehabilitation.

072 Relationships Among a Set of Behavioral Measures of Chronic Pain

Principal Investigator:	W.E. Fordyce, Ph.D.	
Status:	Continuing	
Dates:	July 1977-October 1980	
Cost:	Annual \$11,650 RT Annual \$5,175	Projected Total \$67,000 RT % of Annual Total 36%
Annual Report Reference:	#17, Page 235, R-140	

OBJECTIVES: To study the inter-correlations of a set of behaviorally-based measures by using a "comparable form" reliability assessment strategy. This objective can help to assess the utility of behavioral measures and to identify redundancies in measurement which can be eliminated.

To study the relationships between the behavioral measures and pertinent other information about the patients. This objective can help clarify the nature and extent of relationship between medical and behavioral measures and between personality test patterns and behavioral measures in the chronic pain patient.

METHODOLOGY: All subjects will be patients referred for evaluation of chronic pain problems. Each patient will be examined by one or more physicians, one of whom will coordinate the physician derived elements of the Pain Data Protocol. Data are obtained three ways: physician recording of examination findings and of his/her ratings on selected variables; patient-derived information obtained by a professional who interviews patient and spouse and either records patient verbal report or monitors the patient in completion of checklists, data obtained from two weeks of pre-examination patient recording of activity level of diary forms, and patient recording of MMPI responses.

Eventually some form of multivariate analysis is anticipated. But the present proposal is limited to inter-relationships; accordingly, the major statistical approaches used have been selected according to whether the measures under consideration are ordered into nominal scales, dichotomous variables, or more or less continuous data.

University of Washington

FINDINGS TO DATE: Curtailment of funds necessitated temporary interruption of data accumulation. Data collection resumed on 4/1/79 and is currently underway.

In view of the gap in data collection, it would appear prudent to extend the planned completion date to October 1980.

In the reporting period (4/1/78 - 6/1/79) additional data have been added on 55 patients. There are now virtually complete data on 195 patients.

APPLICABILITY: There are not as yet available precise numbers indicating the rate or percentage of adults having chronic pain problems. The evidence seems clear that there are many and that they present a major burden in suffering, in health care utilization costs, and in expenditure of wage replacement funds. Moreover, the load is particularly high in the labor force, the population which is of particular interest in rehabilitation.

This project addresses itself to one of the basic problems in the management of chronic pain; namely that of identifying the scope and extent of the problem and of how to assess treatment programs.

073 Comparison of Methods to Reduce Shear and Displacement in the Use of a Reclining Wheelchair

Principal Investigator:	C.G. Warren, M.P.A.	
Status:	Continuing	
Dates:	June 1977-January 1980	
Cost:	Annual \$4,830 RT Annual \$4,830	Projected Total \$6,000 RT % of Annual Total 100%
Annual Report Reference:	#17, Page 199, R-145	

OBJECTIVES: The objectives of the study are to quantify the effects of the three proposed mechanisms: 1. relocating the axes of rotation of the wheelchair, 2. incorporation of a powered sliding seat or 3. using a sliding back mechanism. From this information, the optimum method of reducing the displacement between the person's body and the seating surface may be established.

METHODOLOGY: The most important factor to be measured as a criterion for effectiveness of chair modification was found to be displacement of the body relative to the seating surface. To be able to make this measurement more accurately, a powered reclining wheelchair with a powered sliding seat was modified to incorporate a low friction counterbalanced sliding back. The chair was then instrumented to measure the angular change of the back relative to the seat to record displacement of the sliding back, the sliding seat and any motion of the subject's lower trunk or leg segment. This was accomplished using precision rotary and linear potentiometers. The extent of the displacement will be processed by an extant data acquisition system and computer. Quadriplegic persons for whom a powered reclining wheelchair might be indicated will be selected as subjects for the study. They will be placed on a standard cushion and positioned until they are satisfied that they are comfortable and in a normal position for them. The chair will be reclined 5° from the horizontal and held in this position for 3 to 4 minutes, then elevated to the 80° position. The patient will be repositioned if he feels it necessary and the procedure repeated. This process will be repeated 7 to 10 times with each of the various conditions of the chair controlled (i.e., fixed or sliding seat, fixed or sliding back, or both fixed). The data will indicate which mechanisms produce the least displacement of the body with respect to the chair. It will also be used to determine through geometric calculations the center of rotation of the body and the effect that altering the axis of rotation of the wheelchair may have on further reducing displacement.

FINDINGS TO DATE: The low-friction, counterbalance sliding back to measure the displacement of sections of the chair and of the body were designed, fabricated, and evaluated for valid and accurate measurements of displacement, and was determined to be reliable in making these measurements.

Displacement of sections of the chair and of the body during the recline cycle were measured

with each of three proposed solutions to the problem. Evaluation of the first solution (moving the seat rearward) proved, at least in its commercial form, to be ineffective. The use of the moving seat reduced back displacement less than 20% of the total excursion. Allowing the chair back to move with the body did solve the problem; however, the experimental solution is likely to be difficult to implement. Thus it may not meet the ultimate goal of providing an inexpensive mechanism for field installation for people who already have reclining wheelchairs. The third solution (redesigning the hinging mechanism) has been evaluated theoretically. The path the chair back would take has been determined in a sample of ten normals and eight quadriplegic persons. Among the normals, there appears to be a correlation with morphology. However, in the sample of persons with quadriplegia, factors other than morphology seemed to dictate the individual path of the body during the recline cycle.

Currently a four-bar linkage is under design which will follow the average curves of the groups of individuals evaluated. This linkage will be adjustable and fitted to the "test bed" powered recliner, replacing the conventional hinging mechanism, but leaving counterbalanced sliding back mechanism intact. Each previous subject will be tested again in the "new" recliner, using the back displacement measurement provided by sliding back to determine optimal geometry of the four-bar linkage hinge as defined by the least amount of back displacement as compared with the conventional hinge.

APPLICABILITY: This project has a distinct advantage in technology transfer, because it involves collaborating directly with the wheelchair industry to evaluate the optimum method to solve the problem. The findings, we believe, will be directly utilized by industry to produce a mechanism to resolve this problem for the severely paralyzed individual.

Determining which methods of eliminating shear and displacement for the severely paralyzed person would include quadriplegics, people with multiple sclerosis, post polio, congenital defects of the spine, etc. The improved reclining wheelchair may considerably modify the social and vocational rehabilitation goals of this category of patient.

074 Evaluation of Low-Cervical - High Thoracic Orthoses

Principal Investigator:	J.F. Lehmann, M.D.	
Status:	New	
Dates:	June 1978-June 1980	
Cost:	Annual \$8,165 RT Annual \$5,290	Projected Total \$10,000 RT % of Annual Total: 65%
Annual Report Reference:	#17, Page 163, R-147	

OBJECTIVE: The objective of this study is to compare in normal individuals the various available orthoses used for stabilization of low-cervical - high-thoracic fractures including the one now used by the University of Washington to determine which of the orthoses prove to be the most effective in each of the following areas: (1) ability to minimize vertebral displacement and rotation, (2) ease in donning and doffing, (3) good hygiene, (4) ease in checking for pressure problems.

METHODOLOGY: The general approach of this study involves fitting each of the three subjects with each type of orthosis to be evaluated, using the fitting criteria suggested by the orthosis manufacturer and measuring the orthosis' ability to stabilize the low-cervical - high-thoracic spine. The three orthoses to be evaluated are: (1) the Peterson orthosis, (2) the CAMP orthosis, and (3) the University of Washington orthosis with the SOMI superstructure.

Each of these orthoses attaches to the torso and attempts to hold the head stationary on the torso via a rigid frame extending up to the head with pads or cups positioned against the head at the chin and occipital areas. For the purposes of this study, the orthoses will be modified by removing the pads from their supporting frame-work and inserting a piezoelectric, triaxial force transducer (Kristal model #9251) between the pads and the support framework. The vertical and fore-aft shear force components measured by the transducer are outputted to an X-7 oscilloscope via two charge amplifiers.

In a randomly selected order, subjects are instructed to don an orthosis and apply either a

flexion or extension load to the orthosis until a predetermined load level of 25 pounds vertical force and zero pound fore-aft shear force is reached. They are then instructed to maintain that load level while an x-ray is taken of the vertebra of the low-cervical - high thoracic spine (vertebra C3 to T10) from a lateral view. The subjects will rely on the output display of the oscilloscope for visual feedback to monitor and maintain the load levels at the predetermined values.

Subjects are then instructed to apply a load to the orthosis in the opposite direction (either flexion or extension) until the same predetermined load level is reached and maintain that load while another x-ray of the cervical-thoracic spine is taken. This sequence is repeated for each subject wearing each orthosis, applying the same loads to the orthosis in each case.

X-rays from these tests will be evaluated by measuring for each orthosis the amount of displacement and rotation of the vertebrae which occurs from C3 to T10, as seen while loaded in flexion as compared to that seen while loaded in extension. Data on the spinal movement allowed by each orthosis will be used to "rate" the orthosis as to ability to minimize spinal movement, based on the criteria that the "best" orthosis is one which allows the least amount of spinal movement to occur, given the same loading conditions.

Orthoses will also be evaluated by a panel of orthotists for ease of donning and doffing, ease of checking for pressure problems, and ease of application of good hygiene.

FINDINGS TO DATE: The Kristal 9751 triaxial force transducer has been obtained and tests to establish the accuracy, linearity, and repeatability of the device have proven the transducer to be suitable for the purposes of this study. Examples of each of the orthoses to be evaluated have been acquired and the hardware necessary to mount the transducer on each of the orthoses have been constructed. The orthoses are currently being fitted to a test subject in order to evaluate the performance of the measurement equipment under simulated test conditions.

Minor changes in the methodology are being considered. The need for these changes became apparent after increased familiarity with the characteristics of the Kristal piezoelectric transducer. Rather than having the subject load the orthosis until the proper load level is reached and then hold that load while the x-ray is taken it was felt that it would be easier and more accurate to develop a TTL logic system that could tell when the vertical and fore-aft shear forces were above a set threshold and yet below another set threshold by monitoring the outputs of the transducer. If these criteria are met simultaneously the control system would automatically trigger the x-ray machine. This would insure that the x-ray is taken exactly when the load levels are at the proper value. The development of this instrumentation has taken considerably longer than expected therefore an extension of one year is being requested.

APPLICABILITY: Results from this study could be used by prosthetist-orthotics for psychiatrists, orthopedic surgeons, and others in rehabilitation or acute-care settings for stabilization of spinal cord injuries or other spinal damage (i.e., cancer, degenerative joint disease).

075 Feedback Treatment of Flaccid, Spastic, and Ataxic Dysarthric Speakers

Principal Investigator:	D.R. Beukelman, Ph.D.	
Status:	New	
Dates:	September 1978-September 1982	
Cost:	Annual \$14,747 RT Annual \$12,447	Projected Total \$80,000 RT % of Annual Total 84%
Annual Report Reference:	#17, Page 298, R-149	

OBJECTIVES: The general objective of this study is to develop and evaluate treatment procedures for flaccid, spastic, and ataxic dysarthric speakers. The specific objectives are to:

1. Add to our evaluation capability by developing a system designed to objectively measure and visually display the status (timing and position) of the "valves" of the speech mechanism during speech activity.
2. Develop procedures for teaching (a) coordination of the respiratory system and other speech

- mechanism activity, and (b) improved respiratory support for speech.
3. Develop procedures for teaching coordination of vocal vibration (phonation) initiation and cessation during speech.
 4. Develop procedures for improving articulatory (jaw, tongue, velopharyngeal mechanism) coordination and movement during speech.

METHODOLOGY: The Department of Rehabilitation Medicine has authorized the purchase of basic laboratory equipment which will permit measurement of the following parameters: air pressures (air flow rates, acoustic wave forms, and some movement parameters).

Phase 1: In Phase 1 of the current study, the system to measure air pressures will be secured and organized to measure neurophysiological events which occur during the speech act. The speech samples and data interface decisions worked out such that the system can reliably and comfortably gather data from dysarthric speakers and display data on-line for feedback purposes.

Phase 2: In Phase 2, 30 flaccid, spastic and ataxic dysarthric speakers will be followed closely as they are involved in speech treatment programs. The current research will be directed toward development of feedback treatment procedures which will be used to supplement the more traditional procedures. Initially, the following will be attempted.

1. Respiratory control.
 - a. Visual feedback of respiratory volume level, so that patients can coordinate respiratory activities and upper airway activity during speech.
 - b. Visual feedback of the level of intra-oral air pressure obtained in the oral cavity during non-phonated segments (in that situation, oral air pressure equals air pressure below the vocal folds) for a period of five to ten seconds. In this way patients will receive practice in maintaining air pressures necessary for speech in the presence of an air leak (a tube placed in the lips) and thus simulate the respiratory requirements during speech.
2. Laryngeal and respiratory control.
 - a. Visual display of the acoustic wave form and respiratory volume level data to assist the patient in the coordination of phonation and respiration.
 - b. Visual display of the presence or absence of acoustic wave form for aphonic dysarthric patients.
 - c. Visual display of the volume velocity of air flow through the oral tract as an indicator of lack of proximal contact of the vocal folds, and thus breathy voice quality.
3. Velopharyngeal port.
 - a. Simultaneous, visual display of oral air pressure and nasal air flow during non-nasal speech sounds. If velopharyngeal closure is adequate for these sounds, the volume velocity of nasal air flow should be zero or near zero in the face of intraoral air pressure.
 - b. Proper fitting of palatal lifts in dysarthric patients based on intraoral air pressure and nasal air flow data.
4. Articulation.
 - a. Visual display of the initiation and release of intraoral air pressure associated with consonant sounds in relationship to other parameters of the speech mechanism (respiration or phonation or velopharyngeal closure).

During the treatment of these patients, data will not only be taken with the system described in this project, but the following information will also be collected: speaking rate, speech intelligibility, articulation accuracy as well as the analysis of the acoustic parameters of speech which were developed for R-128, i.e. intonation, stress and duration of words and pauses.

FINDINGS TO DATE:

1. Phase I of the current study has been completed; that is, the system described in the project has been purchased and assembled to measure physiological speech events. Feedback information can be delivered to patients through the visual mode. Permanent write-out capability has been integrated into the system.

2. Two patients have completed a training program coordinating the activity of the respiratory system with the phonatory system. The response of one patient was excellent with good generalization of learning. Response of the second patient was very encouraging, in that he modified his respiratory-phonatory coordination while on the feedback system; however, generalization of learning required additional training. A third patient completed a feedback program attempting to reduce nasal emission and nasality during speech. This patient was unsuccessful in modifying these speech parameters. The equipment described in this project also was used to evaluate and guide the fitting of a palatal lift which was prescribed for the subject mentioned above.

APPLICABILITY: The results of this project will improve dysarthria treatment procedures by increasing the amount and detail of feedback provided to speaker and clinician.

076 Quantification of Non-Vocal Communication Performance

Principal Investigator:	D.R. Beukelman, Ph.D.	
Status:	New	
Dates:	July 1978-July 1980	
Cost:	Annual \$7,475 RT Annual \$5,750	Projected Total \$15,000 RT % of Annual Total 77%
Annual Report Reference:	#17, Page 306, R-150	

OBJECTIVES: The aim of this study is to develop a system for quantifying non-vocal communication performance which is sensitive to frequency of communication, type of message, sender efficiency, receiver efficiency, sender fatigability, and system flexibility. The specific objectives will be to:

1. Develop data gathering and analysis procedures.
2. Quantify non-vocal communication performance in (a) a formal evaluation of specific communication tasks and (b) a variety of "natural" communication environments where extensive data can be collected over a period of several hours.
3. Monitor the progress and generalization of learning as non-vocal communicators improve their skill with a specific communication system.

METHODOLOGY: **Phase I:** The first phase of this study will be to develop a data collection and analysis system which is capable of quantifying non-vocal communication performance, is sensitive over a wide range of communicative ability levels and applicable in a variety of communication settings.

Since the capability of data collection over long periods of time in a variety of settings is a primary objective of this study, Phase I will also include development of recording techniques which will permit accurate and reliable data collection by the "receivers" in a specific "sender's" environment. The requirements of the data collection system will be (1) minimal interference with the frequency and type of communication, and (2) accurate, reliable recording of message content, message frequency, device employed, receiver identity, and environmental identification. Preliminary work in this area indicates that a paper-pencil system of recording is inadequate. Therefore, a portable cassette tape-recorder system which will permit receiver to signal the duration of the message in real time and provide specific information requirements provided above is being investigated. This information will then be taken from the tape by a research technician.

A second aspect of the data collection in Phase I will be development of formal evaluation tasks of three different types: (1) Input-output tasks will be used to measure sender efficiency and accuracy; (2) picture or situation description will be used to assess ability to formulate messages on a specific device and to permit quantification of content as well as efficiency of communicative effort; (3) fatigability drills will be used to quantify communication rate. A character (letter or word designation) per minute measure will be calculated to determine changes in communication rate over time thus illustrating the effects of fatigue.

During Phase I, the performance of 10 non-vocal communicators will be evaluated by methods

similar to those above. These communications will represent a wide range of communicative ability, devices, systems and environments. Data will be used to finalize the data collection and quantification systems which have been described above. Some of these communicators will have their own devices and systems. Others will use systems recently purchased by the Department of Rehabilitation Medicine (Zygo 100 square and Lapboard Strip Printer).

Phase 2: Five non-vocal communicators who have recently received new communication systems or systems modified from those that they previously used will be followed so that their learning and generalization of system use can be analyzed. Performance of these communicators will be quantified (four times during the learning phase) with the methods developed in Phase I. The exact recording dates will depend upon the rate with which their skills on their respective communicative systems progress. Performance will be analyzed to determine changes in variety of communications partners, frequency of communication initiation, type of message, frequency of communication, receiver efficiency per communication exchange, and variety of communication environments.

FINDINGS TO DATE: The data collection and analysis system for quantifying non-vocal communication performance in a variety of settings has been completed and field tested. Data has been collected on five non-vocal communicators. Two persons were non-vocal following automobile accidents. One was non-vocal due to amyotrophic lateral sclerosis. Two were non-vocal due to cerebral palsy.

APPLICABILITY: The results of this study have been used in the clinical decision-making processes of three hospitals and one school for handicapped children. The performance evaluations of four of the non-vocal communicators have resulted in some modification of their training programs, equipment, or education of their communication partners.

077 Electromyographic Analysis of Postural Adjustment During Movement of the Upper Extremities

Principal Investigator:	M.E. Anderson, Ph.D.	
Status:	New	
Dates:	February 1978-September 1979	
Cost:	Annual \$13,800 RT Annual \$6,900	Projected Total \$10,000 RT % of Annual Total 50%
Annual Report Reference:	#17, Page 424, R-152	

OBJECTIVES:

1. To determine the normal patterns of EMG activity in shoulder, trunk, and leg muscles during a movement (raising and lowering the arm in a standing individual) that will require postural adjustment to support a displacement of mass.
2. To determine the variability in these patterns between different individuals who do not have neurological or musculoskeletal disorders.
3. To determine the critical task variables that influence the pattern of muscle activity. In particular, we will compare EMG patterns when the arm movements are made at different velocities, when they are self-paced vs. stimulus triggered, and when the required response is randomly varied between the right and left arm.

METHODOLOGY: Subjects were 30 volunteers, ages 20 to 80, who had no history of neurological or musculoskeletal disorders. During testing, they wore clothing that allowed access to muscles acting at the hip, knee, and/or ankle, paraspinal muscles, and muscles around the shoulder girdle. The latter muscles gave timing of activity in the prime movers for the arm movement, and the former are expected to be muscles that provide postural support.

Subjects stood in stocking feet or flat shoes in a comfortable position, with weight distributed on both feet. They faced a panel of lights, and silver-silver chloride surface EMG electrodes (Beckman) were taped to the skin overlying up to 12 muscles (or groups of muscles) at a time.

Differentially-recorded signals from each muscle were amplified by high input impedance, variable filter amplifiers with input stages mounted near the subject, and amplified signals from 5 muscles at a time were transmitted via isolation units to the recording apparatus.

Arm positions were recorded via a low-torque potentiometer aligned with the axis of shoulder rotation and coupled via a universal joint and slide rod to a tube strapped to one arm, with velcro attachments above and below the elbow to keep the elbow straight.

In the initial experimental trials the subject was asked to raise his/her arm from an initial position at the side to a horizontal position as a self-paced (raise: hold: lower: hold) movement with no external trigger signal. For one set of trials the subject was requested to make the movement as rapidly as possible, and in other sets, he made the movement at slower rates.

Finally, in an additional set of trials the subject was asked to raise either the right or left arm, depending on whether the right or left signal light appears in a random sequence.

Data were recorded on FM analog tape. Raw data were filmed from an oscilloscope face on moving kymograph film and projected for measurement of relative EMG timing and amplitude of movement. A digitizer was used to measure EMG onset and offset for each muscle relative to the time of movement onset. The digitizer arm was positioned at the movement or EMG onset or offset of the projected film image, and the X-Y coordinates of the arm position were entered into a computer file as amplitude or time measurements, relative to the onset of the movement. These values could then be used for graphic and statistical analysis.

Using these data a sequential profile of EMG activity in different individuals during arm movements of a few selected velocity ranges can be established, EMG lead or lag times relative to the movement onset for individual muscles during movements at several different velocities and under different task conditions (i.e., triggered, random, self-paced, etc.) can be plotted.

FINDINGS TO DATE: Thirty subjects have been studied, 5 in each decade age group from 20 to 80 years of age. Data analysis is underway.

To date, "the fast as possible" condition has been analyzed for 15 subjects. From these data an EMG "onset profile" can be developed for each subject and use this type of profile to compare subjects. The earliest onsets are in the ipsilateral (right) hip extensor (RBIC) or the back muscles (RPAR or LPARA), **followed** by EMG activity in the ipsilateral anterior deltoid (RDEL), the prime mover. Finally activity in the contralateral hip extensor (LBIC) starts near the time of movement onset and lasts throughout the movement. The activity of the last two muscles (RDEL and LBIC) is quite consistent from subject to subject, and the time **between** EMG onset in these two muscles is very consistent. However, there is more variability in the timing of onset in the muscles with earliest activity. These muscles may play a role in axial "stiffening," so that the ensuing movement causes less displacement in the articulated axial segments, or they may play a role in **initiating** the movement by initiating an early impulse of force to cause a "flinging" action on the arm. That the latter may be the case for the ipsilateral hip extensor is in particular suggested by the fact that activity in this muscle usually occurs as a burst and does not continue while the movement is in progress. Further calculation is necessary to determine whether the delay between the electrical EMG activity was recorded and the mechanical contraction, which would stabilize the trunk, would be appropriate to convert the burst of EMG activity into mechanical stability for at least the high velocity portion of the movement.

During the next year data analysis will be completed, including the analysis of movements performed at different velocities and in the reaction time paradigm. From preliminary analysis of the data, it already is clear that the early recruitment of ipsilateral hip extensor activity does not occur when the movement is made slowly.

Careful analysis of these data will provide a solid baseline for analysis of sequential EMG activity in patients with postural instability characteristic of Parkinson's disease and some types of brain injury.

APPLICABILITY: Evaluation of the normal pattern of postural adjustment in simple tasks performed by normal individuals will give us a basis for evaluating how this process is disrupted in several types of patients. This information will be used to improve motor retaining or compensatory strategies.

078 The Effect of Parachlorophenyl Gamma Aminobutyric Acid (Baclofen) on External Urinary Sphincter Activity in Spinal Cord Injured Patients

Principal Investigator: E.J. O'Shaughnessy, M.D.
Status: New
Dates: January 1978-September 1978
Cost: Annual \$1,150 Projected Total \$2,645
RT Annual \$1,150 RT % of Annual Total 100%
Annual Report Reference: #17, Page 432, R-153

OBJECTIVE: To determine the effect of Baclofen on the external urethral sphincter in relation to voiding in spinal cord injured patients with hyper-reflexic bladders.

METHODOLOGY: This will be a prospective study of spinal cord injured patients on the Rehabilitation Medicine Service at Harborview Medical Center who undergo usual urodynamic studies while hospitalized.

Six patients will be evaluated during six months and considered appropriate candidates for inclusion in the study if they meet all the following criteria: must agree to be in the study and sign an informed consent, have a spinal cord lesion, not in spinal shock and demonstrate the presence of dyssynergia of the external urinary sphincter and detrusor muscles by CMG/EMG studies. A bulbocavernosus reflex should be present by electrical stimulation of the dorsal nerve of the penis while recording an "M" response from the ischocavernosus muscles, and there should be and absence of membrane irritability in the external urethral sphincter by needle EMG. There will be no anticipated changes in any of the following medications which the patient may be taking: diazepam, dantrolene, Dilantin, Urecholine, Pro-Banthine, tricyclic antidepressants or any other drug which may have effects on the external sphincter, and additionally, there should be no anticipated dramatic changes in the patients' level of activity during the study.

Electrical activity of the external sphincter will be of primary interest. Initially, baseline studies will be done on each patient at the time of admission and will include needle EMG of the external urinary sphincter (15), and concomitant bladder volume and pressure studies using water cystometric methods. In addition, the effect of Valsalva and Crede maneuvers on external sphincter activity will be noted.

It is not the intention of this study to attempt to quantify the EMG activity of the external sphincter, but rather to evaluate the relationship between changes in intravesicle pressure with the presence or absence of sphincter EMG activity. Preliminary studies in three patients show that baseline sphincter electrical activity is easily distinguishable from the activity noted during detrusor contraction.

Following baseline studies, patients will be started on a gradually increasing dosage of Baclofen until a maximum dosage of 60 mgm per day is reached. The patient will then undergo the same urodynamic study as was performed during the baseline evaluation. Comparisons between the two studies will be made, and if changes in the activity of the external urethral sphincter with respect to changes in bladder pressure and/or volume are noted, the patient will be slowly withdrawn from the drug. Following a wash-out period of one week, during which time no drug will have been administered, repeat urodynamic studies will be carried out.

FINDINGS TO DATE: Experience of attempting to determine the effect of Baclofen on activity of the urinary external sphincter has not been satisfactory in as much as it was difficult to differentiate the activity as recorded by the EMG electrode in relationship to the drug (i.e., the EMG monitoring did not show change either in the non-challenged state or reflex recruitment). This method alone will not yield a valid analysis of drug effect. Experience now indicates that a summation of the motor unit activity is necessary. Therefore, the plan is to change the method in measuring the activity of the external sphincter.

Six to ten patients will again be evaluated over the next 6 months (who meet the same criteria as previously described) but measuring this by intra-urethral pressure at the external sphincter so as to measure the internal pressure of the urethra on patients before they have had Baclofen, while

they are on Baclofen, and after the Baclofen has been discontinued. A more relative effect of the distal pressure versus the proximal pressure which is the result of detrusor contraction should then tell whether or not Baclofen is an adjunct to the treatment of vesicourethral sphincter dyssynergia.

APPLICABILITY: If the drug in question will in fact reduce vesicourethral dyssynergia, patients with neurogenic bladders described above may enjoy a balanced bladder with resultant decrease of bacteria in the urinary tract. Such a state reduces risk to health and potential hospitalization. If untrue, this should be immediately documented.

079 Interpersonal and Vocational Consequences of Head Injury

Principal Investigator:	E.J. O'Shaughnessy, M.D.	
Status:	New	
Dates:	April 1978-October 1980	
Cost:	Annual \$16,100 RT Annual \$11,500	Projected Total \$32,000 RT % of Annual Total 71%
Annual Report Reference:	#17, Page 512, R-154	

OBJECTIVES:

1. To survey a specific population of patients with closed head injuries to determine if there exists in this population sufficient cognitive deficits to impair post-trauma interpersonal and vocational relationships.
2. To determine, if such cognitive deficits do in fact exist, whether they warrant interventional services.

METHODOLOGY: The patient population will be identified from the daily hospital admission sheet at Harborview Medical Center and will consist of those head injured patients who, for at least 24 hours following injury, demonstrate lethargy, mental confusion, unconsciousness, amnesia, or disorientation, who were employed at the time of the traumatic event, and who were discharged from the hospital to their own care within two weeks.

Patients will be interviewed and tested within one week of injury using sub-tests of WAIS (information, comprehension, arithmetic, similarities, digit span, digit symbol, picture completion, and block design) and the Wechsler Memory scale using the paired associate learning test. In addition, the Edwards Personality Inventory will be used. Data related to the patient's premorbid demographic social, educational, and vocational levels will be elicited from significant others using selected sections of the Regional Spinal Cord Injury Center data protocol forms and the social leisure forms from the Rehabilitation Indicators Project.

Testing will be accomplished again at six months post injury by the psychometrist who will visit the patient and significant others in their home. Analysis of data will be by a descriptive and correlational format. The performance on intelligence tests obtained soon after injury will be correlated with indices of severity of disability and need for services.

"Severity of Disability" and "Need for Services" will be defined on the basis of the social, vocational, demographic, and personality indices of change in a negative direction, e.g., significant loss of income, breakup of the family, loss of job, reduction in academic achievement, reduction in social leisure activity and the absolute magnitude of rated change on the Edwards Personality Inventory. As these will be individuals having experienced relatively mild brain injuries, it is also expected that the absolute change in intelligence test scores will be a useful index of severity of injury. That is, the greater the discrepancy between intelligence test performances the more severe the damage. This too will be correlated with Severity of Disability and Need for Services.

FINDINGS TO DATE: To date 24 patients have been interviewed. Our goal is to interview 50 patients as described in the original methodology. It appears from the numbers accumulated thus far that two rather than one year will be required to amass that number. Therefore an extension of one year will be requested. To date we have experienced no difficulty with the 6-month follow-up portion of the project.

APPLICABILITY: If the objectives are attained as proposed, this would result in a valid basis for construction of vocationally oriented interventions.

080 Relationship of Skin Surface, Subcutaneous and Deep Tissue Temperature on Nerve Conduction Velocity in Normal Subjects

Principal Investigator: E. Halar, M.D.

Status: New

Dates: June 1978-December 1980

Cost: Annual \$ 5,980
RT Annual \$1,150

Projected Total \$19,000
RT % of Annual Total 20%

Annual Report Reference: #17, Page 366, R-155

OBJECTIVES:

1. To determine the effects of skin surface, subcutaneous and deep tissue temperature on tibial, peroneal motor and sural sensory nerves.
2. To determine an equation from which NCV's at a standard skin temperature of 32°C could be calculated from obtained NCV's taken at various temperatures.
3. To determine whether skin surface temperature could be reliably used to correct NCV values.
4. To determine the effect of aging on the different tissue temperatures, measured NCV's, and NCV temperature relationships.
5. To determine the effect of limb temperature variation on actual terminal latencies and "residual" latencies.

METHODOLOGY: Subjects: Forty healthy normal subjects, ranging in age from 20 to 70 years, will be tested. The subjects will be divided by decades into five different age groups (20-30, 30-40, 40-50, 50-60, 60-70). There will be approximately equal numbers of males and females in this study. Persons with peripheral vascular disease, chronic renal failure, diabetes mellitus, alcoholism, or any other known cause of neuropathy will not be included in this study.

Procedure: A brief medical history will be obtained on each subject before each testing. Tibial motor and sural sensory NCV's will be taken after cooling of the lower extremity to skin surface temperature of approximately 25 to 30°C, at ambient temperature (at which skin surface temperature will be approximately 32° and after walking for 15 minutes.

NCV will be determined on the tibial nerve (10) using TECA-TE4 electromyograph modified for use by the double stimulus technique (11). The sural sensory (12) will be calculated with the evoked potential averager on the TECA-TE4. Antidromic stimulation will be applied 14 cm from the active recording electrodes.

From the NCV's of the motor nerves tested, residual latencies will be calculated for the distal segment of the limb. These residual latencies will be compared with the actual distal latencies obtained during testing and compared to temperature variations in the distal part of the extremity. The correlations between temperature variations and distal latencies will be obtained by this measurement. This correlation could potentially be used for assessment of distal neuropathies in patients with peripheral nerve problems.

Temperature will be recorded using a Honeywell Viscodens light oscilloscope Model 9068, adapted for multiple input and a specially designed thermometer (thermister) implanted in a 20 gauge needle. Temperature will be taken on the skin over the midcalf muscles and at the medial malleolus subcutaneously near the sural nerve, and then deep in the muscles of the midcalf close to the tibial nerve. No anesthetic will be used during temperature determination.

Technique: The left leg of the subject will be set up for skin surface, subcutaneous and deep tissue temperature measurement.

To determine the sites for temperature measurements, the subject's leg will be measured from the distal popliteal crease to the medial malleolus. The site for both deep tissue and subcutaneous tissue measurement (Site 1) will be designated as one third of the distance from the popliteal crease to the medial malleolus, between the heads of the gastrocnemius muscle. Skin surface temperature will be measured slightly lateral to Site 1 (Site 2), and two thirds of the distance from the popliteal crease to the medial malleolus (Site 3) and at the medial malleolus (Site 4). The site to be used for subcutaneous and deep tissue temperature determined will be cleaned with Betadine.

Following determination and marking of the sites to be used for temperature measurement, the NCV of the tibial nerve will be determined. A skin surface probe will be placed on Sites 2, 3, and 4 and the needle carrying the thermister will be introduced into the subcutaneous and deep tissue of Site 1. Immediately, temperature measurements will be taken using a Viscoder light oscilloscope for one minute. The needle carrying the thermister will be left in the fatty tissue over the gastrocnemius muscle.

The right leg will have Sites 1, 2, 3, and 4 determined and marked for temperature measurements and Site 1 will be cleaned as before. The sural sensory NCV of the leg will then be measured. Immediately after NCV determination the skin surface, subcutaneous and deep tissue temperatures will be recorded.

FINDINGS TO DATE: In the first part of this study, the relationship between skin, subcutaneous and intramuscular temperature with tibial and sural NCV and H-reflex latency was investigated. Twenty-five normal subjects were tested.

NCV, skin, subcutaneous and intramuscular temperatures were measured first at ambient temperature and then at skin temperatures of approximately 26, 28, and 30°C produced by cooling of the lower extremities. Results revealed a linear correlation between skin, subcutaneous and intramuscular temperatures ($p < .025$). Changes in NCV correlated significantly with the corresponding changes in skin, subcutaneous and intramuscular temperatures ($p > .001$). An equation is being derived which will enable the correction of tibial and sural NCV's to a standard skin temperature of 32°C. H-reflex latency did not significantly correlate with temperature.

The second part of this study will investigate the relationship between skin and near nerve temperature with the NCV of the peroneal nerve. An equation will be derived with which peroneal NCV's could be corrected to a standard skin temperature of 32°C. Also, the temperature effects on the ulnar and median nerves of the upper extremity will be studied. A specific site for skin temperature measurement will be determined for the upper extremities. The correction factor for this site temperature determination and NCV for ulnar and median nerve will be calculated.

APPLICABILITY: Since temperature corrections are used in the every day practice of the electrodiagnostician, standardizing NCV's to a temperature of 32°C would reduce variation in NCV reporting in clinical and research application.

These findings would be used in our laboratory, at the University of Washington, and nationally in other electrodiagnostic laboratories. Also, information about the effect of age on NCV will be provided to electrodiagnostic laboratories in this country.

The findings would enable the electrodiagnostician to standardize his NCV's to reduce the variability in NCV reporting. In this way an NCV could better be judged as abnormally slow.

081 Determining the Incidence of Carpal Tunnel Syndrome in Uremic Patients on Renal Dialysis

Principal Investigator:	Susan Halter, M.D.	
Status:	New	
Dates:	June 1979-June 1980	
Cost:	Annual \$7,360 RT Annual \$3,335	Projected Total Not Specified RT % of Annual Total 45%
Annual Report Reference:	Not Specified	

OBJECTIVES: Most of the previously reported studies of CTS in uremic patients on dialysis are anecdotal and include small numbers of patients. None of the studies, as reported, has met rigid electrodiagnostic criteria for evaluation of CTS. Our experience to date suggests that uremic patients have a higher incidence of carpal tunnel syndrome than previously thought. The purpose of this study is to determine the incidence of CTS in the Seattle VAMC population of uremic patients on renal dialysis, using standardized electrodiagnostic techniques and recording hand and forearm temperature. Patients will be selected from a population of uremic patients who have been on renal dialysis for various lengths of time, the majority for greater than five years.

METHODOLOGY: The majority of patients complaining of symptoms which might correlate with CTS have been on dialysis 5 years $\pm$ 4 months. The total VA population of renal dialysis patients is 100, and 38 of these have been on dialysis 5 years $\pm$ 4 months. Of the 38, one has transferred to Tennessee, and six have had renal transplants and are eliminated from the study. We will attempt to test all of the remaining 31 patients. Twelve of the 31 have symptoms which might be found in CTS, and 19 are asymptomatic.

Any symptomatic patients who have been on dialysis less than 5 years $\pm$ 4 months will also be tested. In addition, a random sample of 10 asymptomatic patients who have been on dialysis for varying times less than five years will be tested.

A DISA will be used for all testing. Rectangular pulses of 0.1 to 0.5 msec will be used with supra-maximal stimulus intensity to 99 milliamps. Temperature will be measured at the midflexor wrist crease and thenar eminence using a Rochester Electromedical Thermistor with surface probe after the subject has been in the room for 15 minutes.

Median and ulnar standardized NCV techniques described by Melvin (12, 13) will be used. For median motor conduction studies, the active electrode will be placed over the opponens pollicis, half the distance between the MCP joint of the thumb and the mid-point of the distal wrist crease. The ground electrode will be placed on the dorsum of the hand and the reference electrode on the distal phalanx of the thumb. The cathode will stimulate the median nerve 8 cm from the active electrode near the wrist and again at the antecubital fossa, just medial to the maximum pulsation of the brachial artery. The distance between the cathode stimulation at the wrist and elbow will be measured with a flexible metal tape. Motor latency at the wrist will be measured from the onset of stimulus to the first deflection. NCV and residual latency will be calculated.

For ulnar motor studies, the active electrode will be placed over the abductor digiti quinti, half the distance between the MCP joint of the 5th finger and the distal wrist crease over the ulnar nerve. The ground electrode will be placed on the dorsum of the hand and the reference on the distal phalanx of the 5th finger. The cathode will then stimulate the ulnar nerve 8 cm from the active electrode and again just below the ulnar groove at the elbow. The distance between cathode stimulation at the wrist and elbow will be measured with tape. Motor latency at the wrist will be measured as for the median nerve. NCV and residual latency will also be calculated.

Orthodromic sensory stimulation will be used to obtain sensory potentials for the median and ulnar nerves. Digital nerves will be stimulated with a flexible metal ring electrode placed at the base of the digit being tested. A similar reference electrode will be placed 4 cm distally on the digit in order to maximize the sensory potential. The 2nd digit will be stimulated to record median nerve potentials and the 5th digit stimulated for ulnar nerve potentials. A dry 4x4 gauze pad will be placed between the digit being tested and other digits to reduce possible cross contamination from other digital nerves. The ground electrode will be placed on the dorsum of the hand. Nerve action potentials will be picked up by electrodes held over the appropriate nerve at the wrist. Latency from the stimulus to the highest point of the negative peak will be measured.

A 1½ inch Teflon coated monopolar EMG needle will be used to test the opponens pollicis, abductor pollicis brevis, first dorsal interosseus, flexor carpi radialis, and cervical paraspinal muscles for evidence of membrane instability, analysis of MUAP configuration and recruitment pattern.

FINDINGS TO DATE: 24 uremic patients on dialysis five years or longer have been tested. Thirteen have carpal tunnel (CTS) syndrome. In addition, 14 patients on dialysis less than five years have been tested and 2 have CTS. Ten more patients on dialysis less than five years are scheduled for testing. We have also found a number of ulnar nerve entrapments.

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The etiology of increased carpal tunnel syndrome in uremic patients is unclear but may be related to ischemia.

APPLICABILITY: Findings may be utilized by physiatrists and nephrologists across the nation. Patients may benefit directly by the alleviation of uncomfortable symptoms and the prevention of possibly severe limitation of hand function. Because of this study, an uncomfortable and potentially harmful condition may be identified and treated more readily.

082 Special Project in Multiple Sclerosis Rehabilitation

Principal Investigator:	George H. Kraft, M.D.	
Status:	New	
Dates:	October 1978-September 1981	
Cost:	Annual \$191,324 RT Annual \$5,297	Projected Total Not Specified RT % of Annual Total 3%
Annual Report Reference:	Not Specified	

OBJECTIVES:

1. To establish coordinated relationships among the Washington State Department of Vocational Rehabilitation, local chapters of the National Multiple Sclerosis Society and the University of Washington's Department of Rehabilitation Medicine and Multiple Sclerosis Clinic.
2. To identify the services necessary for the optimal vocational adjustment of individuals with multiple sclerosis.
3. To explore the rehabilitation needs unique to individuals with multiple sclerosis.
4. To increase the number of multiple sclerosis clients seen by VR counselors in Washington State and to increase the number of those clients successfully rehabilitated.

METHODOLOGY: Activities planned for the project will be in the areas of (a) research, (b) education and (c) service coordination.

Research: The focus of project research is the "Questionnaire on Medical and Social Service Needs of Individuals with Multiple Sclerosis, 1979." Hospitals, clinics, physicians, and local chapters of the NMSS have contacted MS patients from their records requesting them to participate in the study. Patients wishing to do so are sent the questionnaire and asked to fill it out and return. Data will be checked, coded and analyzed. Due to MS symptoms which may prohibit patients from satisfactorily completing the questionnaire, some patients will be interviewed.

The questionnaire will give data relating disability levels and symptomatology to medical, social service and vocational needs of a population of MS patients and enable researchers to select individuals for further study in an effort to determine the vocational and psychological adjustment to MS. Project staff will consult with other Center researchers in the area of MS speech pathology, occupational therapy, bioengineering, and bowel and bladder management.

FINDINGS TO DATE: Activities undertaken to accomplish the objectives include meetings and discussions with agencies, educational efforts aimed at improving the knowledge of rehabilitation professionals who serve multiple sclerosis clients, conducting research into the medical and social needs of multiple sclerosis clients, following MS clients through the vocational rehabilitation process so as to become more aware of their special needs, collecting baseline data on vocational rehabilitation services received by MS clients, and providing medical services through the University of Washington Multiple Sclerosis Clinic.

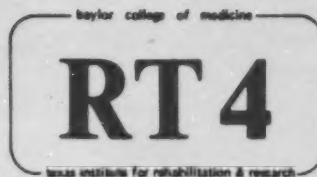
Project related research efforts have been directed into two related areas: application of existing knowledge of MS to rehabilitation and the search for new knowledge which can improve MS rehabilitation. Development and revision of the **Handbook on Multiple Sclerosis Rehabilitation** has been one outcome.

Preliminary research information was compiled by conducting a survey. The questionnaire is

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currently being sent to MS patients in western Washington. Data will aid in understanding the specific medical and social service needs of MS patients, their vocational decisions, the extent of disabilities produced by MS, our ability to predict the future course of the disease in individual cases. The survey of MS patients may also provide the impetus for developing an MS patient registry and will also serve as the basis for selecting patients to study. Follow-up studies are currently being planned.

APPLICABILITY: From this project a model plan for MS rehabilitation may be developed. This plan would have as its components effective cooperative arrangements between public and private agencies and knowledge of the services necessary for optimal vocational adjustment of MS clients. Data gathered in the study should make it possible to determine the cost-effectiveness of vocational rehabilitation in MS. The project will be a demonstration of how a cooperative arrangement can be worked among different public and private agencies concerned with the same problem. More individuals with MS will have a greater access to VR, medical and other patient services which are expected to meet the needs of MS patients more nearly than those presently offered.



**Baylor College of Medicine (RT-4)
Medical Rehabilitation Research and Training Center**

CORE AREAS

**The Comprehensive Rehabilitation
of Persons with Severe Spinal Cord Injury**

Describing and analyzing the mechanisms of the functional limitations and disability that are involved, devising new and more effective treatment procedures, evaluating systematically the outcomes of specific rehabilitation services, developing improved services that will enable persons with severe functional limitations to live productively in the community.

**Rehabilitation of Patients
with Ischemic Heart Disease**

Evaluating the effects of reconditioning exercise for these persons and the physical and biochemical bases of these effects.

**Behavioral Ecological Studies
of the Comprehensive Rehabilitation Process**

Assessing the patient's progress both inside and outside the hospital and the effectiveness of specific rehabilitation programs.

**Rehabilitation-Related Applications
of Biostereometric Methodology**

Rehabilitation-related applications of biostereometric methodology to providing precise quantitation of the three-dimensional geometry of body deformities and limitations of motor functioning.

BAYLOR COLLEGE OF MEDICINE

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COMPLETED

ABSTRACT NO.

- Immediate Stabilization of the Fractured Thoracic and Lumbar
Spine With and Without Neurologic Deficit
(J.H. Dickson, M.D.) 083

CONTINUING

- Appropriate Entry Level Jobs and Sheltered Workshop Tasks for
the Less Educated, Severely Physically Handicapped
With Upper Extremity Impairment (W. Alfred, M.A.) 084
- Transitional Living: A Program Fostering Community Integration
of Severely Physically Handicapped Persons
(J.A. Cole, Ph.D.) 085
- Clinical Implications of the Disturbance in Calcium and
Collagen Metabolism in Quadriplegia
(J. Claus-Walker, Ph.D.) 086
- Application of a Neurophysiologic Profile to Predict Responses
to Treatment of Abnormal Movements Associated with
Severe Spinal Cord Injury (M. Dimitrijevic, M.D., D.Sc.) 087
- Clinical Application of Longitudinal Functional Assessment
(E. Willems, Ph.D.) 088
- Stereometric Analysis of Static Equilibrium in Patients with CNS
Disorders (R.E. Herron, Ph.D.) 089
- Stereometric Measurement of Thoracolumbar Mobility in
Scoliosis With and Without Fusion (R.E. Herron, Ph.D.) 090
- Cardiac Rehabilitation Program for Patients with Myocardial
Ischemia and Arterial Hypertension (D. Cardus, M.D.) 091
- A Longitudinal Study of the Course of Vocational Development
Following Severe Spinal Cord Injury (W. Alfred, M.A.) 092

NEW

- Evaluation of the Effects of Spinal Stimulation on Motor
Performance in Patients with Upper Motor Neurone
Lesions (M. Dimitrijevic, M.D., D.Sc.) 093
- Demonstration and Evaluation of a Model Surveillance System
for Neurological Active Drugs Used in Spinal Cord
Injured Patients (L. Halstead, M.D.) 094

DEFERRED

- Development of an Optimal Discriminant Function for the Early
Detection of Scoliosis (R.E. Herron, Ph.D.) 095

DISCONTINUED

- Cervical Spine Injuries from Recreation and Sports
(L.S. Kewairamani, M.D.) 096

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PROPOSED

The Role of Respiratory Muscle Fatigue in Neuromuscular Disease

Validation of the Criteria for a Form of Better Functioning Architecture for All People, Including Those with Severe Functional Limitations

1979 Survey of Disability in Houston, Texas

083 Immediate Stabilization of the Fractured Thoracic and Lumbar Spine With and Without Neurologic Deficit

Principal Investigator:	J.H. Dickson, M.D.	
Status:	Completed	
Dates:	July 1975-October 1979	
Cost:	Annual \$62,899 RT Annual \$56,738	Projected Total \$139,000 RT % of Annual Total 90%
Annual Report Reference:	#17, Page A-1, R-167	

OBJECTIVES:

1. To document from an orthopedic standpoint the degree of reduction and durability of stabilization that is achieved by instrumentation applied shortly after fracture of the thoracic or lumbar spine.
2. To document how soon following surgery the patient can be made bed-free in order to participate fully in the rehabilitation process.
3. To document complications directly related to the surgery.
4. To communicate the benefits of spinal instrumentation to orthopedic surgeons and neurosurgeons caring for patients with severe spinal injury.

METHODOLOGY: Patients with unstable, fractured spines at the thoracic or lumbar levels were submitted to immediate reduction and stabilization using Harrington instrumentation. From a posterior approach, the distraction force was applied on both the right and left sides, the span of the instrumentation being two vertebrae above and two below the fracture level. The patients were followed by the surgical staff from the time of surgery until the post-operative course was completed and the physician of the TIRR Regional Spinal Cord Center had assumed responsibility. Patients then were followed at 3, 6, and 12 month intervals, and thereafter, at 2 or 3 year intervals. Patients who had similar procedures at other hospitals before transferring to TIRR were included in the study.

Protocols for recording patients' data were adapted from those used in Project R-10, "Collection and Analysis of Clinical Data of Scoliotic Patients." The data derived from photos of all x-rays including those taken pre- and post-injury as well as in follow-up examinations. Information concerning the operation itself included blood loss, operative time, and complications. Follow-up examinations focused upon: (1) degree of reduction; (2) maintenance of reduction; (3) development of fusion; and (4) time until the patient was able to be up in a wheelchair.

FINDINGS TO DATE: Outcomes obtained for this series of patients are consistent with the findings reported for 95 patients (Dickson, Harrington, & Erwin, 1978). In that series, the mean pre-operative angle of deformity was 31 degrees and the mean displacement, 46%. Post-operatively, the corresponding mean measurements were 11 degrees and 10%. At subsequent follow-up, the measurements were 15 degrees and 9%. Using the criteria developed by Frankel and associates for assessing neural function, improvement of one or more grades was evident in 48% of the patients. For the 51 patients with incomplete loss of function, 75% showed an improvement of at least one grade. Important differences were not demonstrable for patients who had the operation on the day of injury as compared to those who had it 8-35 days later. Twenty-eight complications were encountered after the 95 operations. This does not constitute undue risk if juxtaposed to the benefits associated with being able to mobilize patients quickly and thus avoid the problems associated with recumbency as the alternative treatment technique. Specifically, the total hospital time for patients in this series averaged 107 days from time of injury.

With regard to the entire series, it can be concluded that patients show excellent reduction and stabilization, a reasonably low incidence of complications, and a gratifyingly short time until they are able to function from a wheelchair. However, the available evidence does not support the hypothesis that the procedure results in a better return of neurologic function than the approach based on postural reduction. The effort to substantiate such an outcome must be based upon a larger series of patients in order to accommodate the wide range of differences among patients.

APPLICABILITY: Systematic documentation of patient outcomes achieved by immediate stabilization of the unstable fractured spine permits this approach to be compared with outcomes achieved by the non-surgical approach involving protracted bedrest. It was expected that the comparison would show that immediate stabilization would permit the patient to participate more rapidly and actively in the inpatient rehabilitation process, and thus shortening its duration. As a result, the patient would be able to more quickly pursue the educational or vocational aspects of rehabilitation. These outcomes have obvious implications for reducing the costs of rehabilitative care—as does the likelihood that immediate stabilization would eliminate the costly complications of extended bedrest including urologic, skin, metabolic, and peripheral vascular problems.

084 Appropriate Entry Level Jobs and Sheltered Workshop Tasks for the Less Educated, Severely Physically Handicapped With Upper Extremity Impairment

Principal Investigator:	W. Alfred, M.A.	
Status:	Continuing	
Dates:	July 1975-June 1980	
Cost:	Annual \$27,686 RT Annual \$18,614	Projected Total \$129,000 RT % of Annual Total 67%
Annual Report Reference:	#17, Page A-214, R-168	

OBJECTIVES:

1. To document the details of successful entry level job experiences and sheltered workshop tasks that can be performed productively by severely physically disabled individuals who have upper extremity impairments and who have less than a four year college education.
2. To develop and evaluate two inventory formats containing the details described above for utilization by VR counselors and sheltered workshop personnel interested in providing improved services to the severely physically disabled.
3. To publish and disseminate the two inventory guides to VR counselors, sheltered workshop personnel, and rehabilitation practitioners involved in providing services to the severely physically disabled.

METHODOLOGY: In terms of the severely physically handicapped, the project includes the disability groups with which the RT-4 Center is identified, viz., spinal cord injury, neurological disease, brain injury, CVA, skeletal systems deformities, amputation, multiple sclerosis, muscular dystrophy, birth defects, chronic and severe arthritis.

From these disability groups, the project is limited to those (1) who manifest functional impairments in one or both upper extremities such as paralysis, spasticity, weakness, amputation, incoordination, deformity, and limited range of motion (2) who have less than a college education.

It is estimated that approximately 15-30 with the aforementioned disabilities and functional impairments will be entered into the program each year. The referral sources will include TIRR and the Texas Rehabilitation Commission.

To date, information on 37 clients has been registered.

1. Entry level jobs for this project are defined as jobs which require no specific vocational preparation beyond on-the-job training and/or less than six months of skills training. The criteria by which a severely handicapped person is judged as successfully and gainfully employed are: (a) receipt of minimum wages or above; (b) demonstrated ability to perform job assignments; (c) maintenance of employment for a minimum of 30 days.
2. For sheltered employment to be considered remunerative, the handicapped individual must demonstrate that he is capable of producing work at a rate of not less than the minimum floor wage that has been established by the U.S. Department of Labor for sheltered workshops; that is not less than 50% of the minimum labor wage. At TIRR's WAP, the floor wage is \$1.33 per hour. If a worker's productivity falls below this level, then he is considered as a slow and unproductive worker

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who cannot generate enough income to contribute to the financial solvency of the workshop operations and programs.

3. Before finalizing decisions as to what specific data to include in both reporting formats, other RT Center personnel, RT-4 Regional Advisory Council members, state VR administrative personnel and counselors, as well as sheltered workshop personnel will be consulted as to their views of the kinds of information that would be most useful.

FINDINGS TO DATE: The final format resulted in a composite job inventory which contains:

1. a client profile which contains vocational relevant information and history about the disabled individual;
2. a job profile which presents basic factors about the job including identification information, employment requirements, job duties, and working conditions;
3. a client job profile which reveals an assessment of disability/job factors, work modifications, and client benefits.

The following sequential steps are being pursued:

1. Development of a preliminary model in consultation with local State VR counselors and administrative personnel, TIRR vocational and workshop staff, local workshop personnel and with the RT-4 Regional Advisory Council.
2. Evaluation of the proposed inventory with examples by a larger number of rehabilitation practitioners located in other RT centers. State VR agencies, sheltered workshops, and rehabilitation which serve the severely disabled. Their input will be obtained by means of an evaluation form.
3. Revision of inventory based on responses received from practitioners.
4. Publication and dissemination of inventory on a national basis.
5. Establishment of a clearing house to receive new data from contributors and dissemination of enlarged inventory at intervals.

The entry level job inventory has progressed to Step 2. The proposed model, which underwent nine significant revisions, was developed in consultation with the rehabilitation professionals outlined in Step 1. Recently the inventory format with examples was printed and distributed to 100 rehabilitation professionals for their evaluation by means of an evaluation form. These professionals represent individuals from 22 states who have expressed interest in the project. Currently responses to the evaluation form are being awaited prior to final revision of the format and publication of the inventory for dissemination on a national basis.

At TIRR Vocational Industrial Center, data on entry level jobs have been completed on 37 severely disabled clients.

The sheltered workshop task inventory will reach Step 2 by September, 1978. Current attempts are being made to simplify the data recording form. At the TIRR Vocational Industrial Center, data on six subcontracts comprising 22 workshop tasks have been acquired.

APPLICABILITY: The potential benefits of the project can lead to improved vocational services for the less educated and severely physically handicapped population with upper extremity impairments in a number of ways:

1. development of more appropriate vocational assessment techniques;
2. development of more adequate sheltered workshop programs to meet their needs;
3. improvement in vocational rehabilitation guidance and counseling services;
4. increase in number of job opportunities and placement possibilities for them;
5. reduction in their financial dependency on government sources; and
6. greater increase in their social and economic independence.

085 Transitional Living: A Program Fostering Community Integration of Severely Physically Handicapped Persons

Principal Investigator: J.A. Cole, Ph.D.
Status: Continuing
Dates: June 1976-December 1979
Cost: Annual \$199,917 Projected Total \$719,000
RT Annual \$21,982 RT % of Annual Total 11%
Annual Report Reference: #17, Page A-108, R-172

OBJECTIVES:

1. To trace internal processes of development in the transitional living program, focusing on changes in goals, methods of planning, program content, and in other areas.
2. To analyze the project as a social system, examining roles, interpersonal relationships, and patterns of interaction among staff members and participants.
3. To examine external relationships between the transitional living project and other organizations with particular emphasis on relationships with the host rehabilitation hospital and the state vocational rehabilitation agency.

Sub-study II: A Study of Program Effects and Outcomes

OBJECTIVES:

1. To determine the behavioral effects of the transitional program.
2. To determine the informational effects of the transitional program.
3. To determine the attitudinal effects of the transitional program.
4. To determine what specific effects the program will have on certain types of individuals and to develop a means of predicting relative outcomes.

METHODOLOGY: The anthropological study of program development utilizes observation, weekly calendars, logs and other routinely maintained records, participant diaries, and interviews with participants, staff, and personnel from outside organizations to document the evolution of the project and its operation as a service delivery system.

The longitudinal study of program effect and outcomes employs a series of measures which are made before, during, and after persons participate in the program to determine the effects of the independent variable (program) on individuals' behavior, attitudes, and information base. Data collection methods include intake and referral documents, wheelchair odometers and rest time monitors, functional activity and performance scales (Tufts Long Range Evaluation Summary), behavioral logs, informational quizzes, and questionnaires.

FINDINGS TO DATE: During New Option's third year of operation, the program continued to operate as a service delivery system and to refine and evaluate methods for teaching independent living skills. These efforts have been reviewed at length in previous RT reports on this part. In addition to continuing these activities, the project also evolved in several new directions during its third year.

1. Development of audio-visual materials;
2. increased emphasis on interaction within the residential system as an experiential learning tool for participants and attendants; and
3. emphasis on follow-up research.

During the project's third year an intensive effort was made to interview each former New Options participant in depth. This is part of the overall effort to collect and analyze comprehensive data on the project to produce a thorough final grant report evaluating the effectiveness of New Options. Research developments are discussed at length in the section below.

Longitudinal Research on Individual Outcomes: During the past three years, twenty-two New

Options cycles have been completed. One hundred twenty-six persons have started as participants in the program, and one hundred one persons have finished the course. Of those who were admitted, ninety-nine were male and twenty-seven were female. Eighty-three percent of the program participants were spinal cord injured. The rest were severely disabled as a result of cerebral palsy, muscular dystrophy, polio, brain damage, spinal bifida, rheumatoid arthritis, cerebellar dysfunction, and ataxia. Most of the individuals in the program were from twenty to thirty years old. The exact age range was from 17 to 53 years. Thirty-one percent of the participants were non-white.

One variable which may prove to be critical in determining who could benefit most from the New Options program is time since onset of disability. Thirty-one percent of the participants in the program had been disabled less than two years when they entered New Options. The most recent time since onset of disability was five months. Another thirty-one percent of the program participants had been disabled two to five years before they came to New Options. Finally, thirty-eight percent had been disabled more than five years before they participated in the program. The longest period from onset of disability to admission in New Options was twenty-nine years.

Another critical variable which may be tied to potential to benefit from this program is the individual's pre-admission living arrangement. Approximately half of the participants came from rural communities and the other half were from metropolitan areas. Perhaps more importantly, eighty-two percent of the New Options participants were living with their family before they came to the program and the remainder from institutionalized settings such as junior college, hospitals, and nursing homes. With respect to transportation, all but two of the participants were dependent on someone else to drive them. Seventy-five percent of these individuals depended directly on family members or close friends.

APPLICABILITY: Many of the functional skills and the psychological and social coping abilities that serve well within a rehabilitation hospital are inadequate resources as severely physically handicapped individuals leave this specialized protected environment and return to the larger society. Some persons manage to bridge the gap successfully between the institutional environment and the community, but these are usually persons with exceptional capabilities and resources. Current rehabilitation programs are largely lacking in methods to assist physically impaired persons in making this transition. For many handicapped persons, the demands of independent living and of educational or vocational productivity are more than can be managed simultaneously. Consequently, many potentially productive persons never have a chance to become independent, and they either retreat or are pushed into isolated environments. The New Options project is intended to develop and evaluate transitional programming designed to bridge this serious gap in rehabilitation services. Community integration and an active lifestyle can become feasible goals for many handicapped persons if they are taught and can practice new adaptive skills and if they are allowed to deal with stresses and assume responsibility in a segmented sequence.

086 Clinical Implications of the Disturbance in Calcium and Collagen Metabolism in Quadriplegia

Principal Investigator:	J. Claus-Walker, Ph.D.
Status:	Continuing
Dates:	December 1976-August 1980
cost:	Annual \$94,543 RT Annual 88,911
	Projected Total \$221,000 RT % of Annual Total 94%
Annual Report Reference:	#17, Page A-6, R-173

OBJECTIVES: The **first objective** of this project is to find (1) the bone and collagen related metabolic effects of extensive muscular disuse in man; (2) the additive effects of complete recumbency; and (3) how both effects are influenced by muscular exercises and by sitting.

The **second objective** of this project is to find out if urinary tract calculi and/or ectopic bone are initiated while the patients have large increases in circulatory and urinary collagen metabolites and urinary calcium.

METHODOLOGY: **Description of subjects:** The 20 male patients included in this project will be Houston residents who have sustained functionally complete cervical cord injuries: 10 of these will have been injured less than a month and be entering The Institute for Rehabilitation and Research for the first time, and 10 others will be returning to this hospital at least 2 years after onset of paralysis. **Record of progress and activity:** A procedure has been developed to document the patient's status every week during his hospitalization. The data will be used to establish scores for sitting and for muscular activity. **Urine collection and analysis:** Urine, collected on ice daily from the admission day to the discharge day, will be analyzed in pools of 7 days for the early patients and 2 to 3 days for the chronic ones. Calcium, hydroxyproline, and non-dialyzable hydroxyproline will be evaluated. Hydroxylysine glycosides will be evaluated. **Urine extracts:** Urine extracts of 7 or 3 days urine pools will be prepared and stored "in vacuo." **Tetracycline marking:** During a period of high hydroxyproline excretion we will give the patient, after obtaining his written consent, 2 doses of 500 mg tetracycline for 2 consecutive days. In case the patient develops urinary calculi and/or ectopic bone, the specimens will be examined under ultra violet light to detect a fluorescent line corresponding to calcification processes progressing at the time when tetracycline was administered. **"In vitro" experimental effects of urine extracts:** A synthetic urine-like solution has been prepared with variable calcium uric acid, and hydroxyproline concentrations. The solutions will be examined to detect the possible formation of crystals during 4 hours incubation at 37°C. The experiments will be repeated with the urine extracts. Traces of heparin were used in the "in vitro" crystallization experiment to assess whether or not this acid product modifies the precipitation kinetics. If crystallization is observed, the necessary conditions will be reproduced in the presence of 10 mg tetracycline. The crystals will be examined under fluorescent light and x-ray diffraction. **"In vivo" experimental effect of urine extract in rats:** Extracts will be made into the form of pellets containing 60 mg of extract. Urine extracts with low hydroxyprolinuria will be used for controls. Test pellets will be placed with a pellet injector near the right foreleg and hindleg, and the control pellets will be placed near the left legs of 20 rats. The animal will be palpated weekly to detect ectopic bone growth.

FINDINGS TO DATE: From June 1, 1978 to July 31, 1979, ten new patients participated in the R-173 project. All urines were processed for total hydroxyproline, hydroxyproline polypeptides, calcium, phosphates, and extracts. Aliquots were stored for hydroxylysine glycosides evaluation. Some chromatographic fractions of the extracts were sent to Dr. Charles Pak, at Southwestern Medical School, Dallas, to study their effect on crystal formation.

The findings to date confirm that the initial trauma leads to increased bone turnover and to a general increase in collagen turnover. In patients injured over 3 years, the osteoporotic bone is very slow to lose more calcium during prolonged recumbency, whereas the increase in collagen turnover occurs rapidly. A recurrent hypercalcemia occurred in one quadriplegic patient. This complication interfered with the research protocol, but the patient was kept on the study, because it was felt that many subjects have transient hypercalcemia. In addition, this hypercalcemic quadriplegic patient, who was given calcium-free intravenous feeding for 5 weeks, had a large increase in calciuria (over 100 mg per day) and hydroxyprolinuria.

The free amino acid profile shows that free hydroxyproline was not increased in quadriplegic patients when compared to health subjects. In contrast, the excretion of total free amino acid and of 3-methylhistidine is reduced in the patients.

The administration of flavonoids has no effect upon the excretion of calcium, phosphorus or hydroxyproline in the 3 quadriplegic patients who were given the food supplement 10, 12, and 13 weeks after the injury, for 7, 9, and 16 weeks.

The "in vitro" studies are now completed, including the tetracycline incorporation. Each sediment weight has been compared at various pH. The results show that alkalinity is the predominant factor to produce heavy sediments with calcium crystals. The addition of heparin, in the presence of increased uric acid, produced more sediment in acid urine but did not affect statistically the weight of the sediments in more alkaline urine. At similar pH, Proteus was more efficient than alkali to initiate a heavy precipitation. More descriptive results will be available after examination of the microphotographs and x-ray diffraction identification. The same "in vitro" experimental procedure was carried out with and without tetracycline. Sediments with tetracycline showed a typical fluorescence which increases together with the alkalinity of the fractures and with the increase in the weight of the sediments. Therefore, it is very likely that the tetracycline fluorescence

can be used to date the appearance of these pathological calcifications. The method "in vitro" can be used to test drugs which may interfere with calcium-containing crystal aggregations.

APPLICABILITY: This project was designed to yield a better understanding on the role of muscular activity and sitting and their biochemical effects on the formation of urinary stones, ectopic bones, and skin ulcers in quadriplegic patients. The original loss of bone and skin cannot be avoided, but the improvement of bone and skin anabolism and shortening of the duration of the bone loss and their relapse, all may be prevented by physical, and perhaps also pharmacological, management. This will allow the patient to accede to professional rehabilitation at an early stage of paralysis, and to be able to maintain optimum functional capability, giving more independence and a better chance for continuous employment. This achievement will reduce hospital and rehabilitational costs and lower the occurrence of re-hospitalization and its additional cost.

087 Application of a Neurophysiologic Profile to Predict Responses to Treatment of Abnormal Movements Associated with Severe Spinal Cord Injury

Principal Investigator:	M. Dimitrijevic, M.D., D.Sc.	
Status:	Continuing	
Dates:	October 1977-October 1980	
Cost:	Annual \$128,842 RT Annual \$77,184	Projected Total \$302,000 RT % of Annual Total 60%
Annual Report Reference:	#17, Page A-18, R-174	

OBJECTIVES: The specific objectives of this investigation are to:

1. Perform comprehensive neurological and electrophysiological testing to develop objective criteria for classifying muscle groups of spinal cord injured patients in terms of being (a) under volitional control, (b) under volitional control when facilitated by such maneuvers as neck reflexes or vestibular reflexes, (c) activated only involuntarily by segmental reflexes or by indirect factors such as tonic vibratory reflexes, or (d) unresponsive.
2. For patients with selected muscle groups falling into one of the first three categories in item 1 above, develop operational procedures for selectively modifying the segmental reflex mechanism to achieve functional goals.
3. Assess possible correlation between types of control and other factors such as level of the lesion, kind of trauma, and clinical signs at different stages after the injury.

METHODOLOGY:

1. Population Sample - The study group will consist of approximately 50 patients from the Spinal Cord Injury Service of the Texas Institute for Rehabilitation and Research who experienced a traumatic injury of the cervical or thoracic region of the spinal cord at least eighteen months previously. This lengthy recovery period is believed desirable to provide a stable baseline of physical, physiological, psychological, and medical findings against which any changes in behavior resulting from specific interventions might be measured.
2. Instrumentation - The Neurophysiology Laboratory is arranged and equipped to support a large variety of measurement techniques and experimental procedures. The capability for essentially any electrophysiological technique required exists through the ability to measure electrical and mechanical events, record or store these signals, process them and display them, and to generate the necessary patterns of electrical and mechanical stimuli to elicit the desired response. These capabilities include wide band amplifiers and paper and magnetic tape recorders, general and special purpose digital computers and externally controllable isolated electrical stimulators as well as continuous and intermittent mechanical stimuli.
3. Neurophysiological Analysis of Residual Motor Control - Each patient in the study group will undergo a series of tests using electrophysiological techniques designed to determine the presence or absence of residual control of motor functions by the brain. The tone of selected muscles supplied by nerves arising above and below the lesion will be monitored by recording the response to

controlled tendon taps. Similarly, the volitional and reflex control of these muscles will be detected by recording the electromyographic activity associated with volitional and reflex events. This neurophysiological investigation will provide evidence for an analytical differentiation of muscle activity which is produced by:

- (a) volitional control
- (b) volitional control requiring facilitation by such maneuvers as neck reflexes or vestibular reflexes
- (c) involuntary or indirect factors such as tonic vibratory reflexes.

Neurophysiological analysis of residual motor control will describe motor unit activity of selected muscle groups, the motor unit activation pattern, and evidence of concurrent and reciprocal muscle activity between antagonistic and synergistic muscle groups during attempts at volitional and postural reflex activation. Additionally, we shall examine the effects of volitional reinforcement on tendon jerk amplitudes by comparing averaged numerical values as well as determining the average amplitude variations during rest and during volitional reinforcement. Measurement of vibratory-induced tonic reflex in selected muscles such as the quadriceps femoris represents an independent parameter for the determination of segmental and supra-segmental functional and anatomical integration of the spinal cord.

Each of the patients will be the subject of a program planning conference, involving representatives of the medical staff, the Clinical Neurophysiology Laboratory, and the physical therapy staff, to plan a specific program designed to gain maximum functional use of any residual motor control potential reflected in the neurophysiological profile. Following the initial conference to identify potential short-term and long-term goals for the patient, these potential goals and the possible means for achieving them will be discussed in detail with the patient and a significant member of the family. In some instances surgical or chemical procedures may be indicated to deafferent selected cutaneous zones and thereby reduce the intensity of spasticity as well as the sensitivity to gross muscle spasms.

The physical therapy program will focus on teaching the patient specific techniques to trigger, augment or suppress motor activities below the level of the lesion which are of practical importance in improving the quality of life for the individual, such as triggering flexion and extension reflexes at appropriate times to assist in transferring from one position to another. Specific techniques may include the use of biofeedback and electrical stimulation of trigger points.

FINDINGS TO DATE: During the past thirteen months a neurophysiologic profile has been obtained for each of 40 patients with spinal cord injury who have been referred to the Department of Clinical Neurophysiology because of severe spasticity which interfered with their ability to perform certain functional activities. Of these, 29 had injuries of the cervical segments of the spinal cord, 9 had injuries of the thoracic segments and 2 had injuries of the lumbar segments.

The information gained from the poly EMG test is proving helpful in establishing the relative degree of preservation of voluntary activation or inhibition of target muscles as well as the relative degree of preservation of long loop reflexes.

Data collection is proceeding on schedule. We are now beginning to analyze some of the results and to organize them in a form which will facilitate making comparisons.

APPLICABILITY: The work undertaken in this project is directed toward minimizing the consequences of paralysis of limbs resulting from traumatic injuries to the spinal cord of man. Decisions about allocation of concentrated rehabilitation services should be based on neurophysiological documentation of the existence of preserved pathways. Only those who can potentially benefit should undergo the training program. In these selected candidates, special techniques will be devised to bring bothersome segmental reflexes under increased control so they can be used for transfer activities or maintaining equilibrium of the body. Preservation of nervous control rather than denervating spastic muscles will have the additional benefit of retaining the trophic function of nerves on the innervated muscles thereby helping to avoid the development of atrophy, edema, and phlebitis. Rehabilitation practitioners have long recognized the significant role of the control of posture in the prevention of trunk deformities and the importance of posture in patient adaptation to support vehicles. From our preliminary work, we anticipate that patient use of residual suprasegmental control of segmental organization in initiating or halting gross movements is possible and that it will significantly improve the quality of life for these patients.

088 Clinical Application of Longitudinal Functional Assessment

Principal Investigator:	E. Willems, Ph.D.	
Status:	Continuing	
Dates:	October 1977-October 1981	
Cost:	Annual \$152,897 RT Annual \$124,634	Projected Total \$389,000 RT % of Annual Total 82%
Annual Report Reference:	#17, Page A-154, B-176	

OBJECTIVES: We are developing an approach to measuring functional performance in rehabilitation called Longitudinal Functional Assessment (LFA). The LFA is both a perspective on rehabilitation and a set of techniques based on continuous, direct monitoring of patient activities during hospitalization and postdischarge. Goals for the project period are to: (a) finish the design of a refined LFA that can be used with many patients simultaneously; (b) begin extensive collaboration between clinical teams and the research team; (c) phase out involvement of the research team in the collecting and interpreting of performance data; (d) transplant the LFA to clinical teams in a number of other institutions involved in comprehensive rehabilitation; (e) package the manuals and training procedures; and (f) offer training workshops and internships for dissemination.

METHODOLOGY What to Measure: One of the themes guiding the project work has been to develop key indicators of patient performance status. We now have such a set of measures referred to as behavioral vital signs. These vital signs were determined from our data archive, which includes over 28,000 instances of patient behavior described in detail during more than 2500 hours of direct patient monitoring. An analysis procedure was developed to map out the data archive based on a dimensional approach to the data. First, the variables were intercorrelated in order to locate obvious redundancy and to establish a common metric among the variables. The second step was a principal components factor analysis. The output of the principal components analysis was analyzed with a hierarchical cluster analysis routine.

How to Get the Measures: The LFA consists of four component sets of tools: (a) direct patient monitoring, (b) instrumented patient monitoring, (c) the environmental negotiability survey (ENS) and (d) the telephone structured interview (TSI). The ENS and TSI are finished and ready for use by clinical personnel. Three instrumented measures of patient activity being developed are the wheelchair odometer and two closely related electronic monitors which measure time out of bed (the RTM, rest-time monitor) and the amount of time spent sitting in a wheelchair (the STM, sit-time monitor).

The direct patient monitoring component of the LFA consists of four procedures. First, for detailed, descriptive monitoring of patient activity, we have the narrative observation procedure with which we began our work. Second, our noteform observation procedure is a more practical and less time consuming approach to gathering the same detailed data produced by the narrative. Third, the Performance Assessment System (PAS) is based on the behavioral vital signs established for SCI patients and represents the most efficient, most stream-lined direct observation procedure available. Fourth, having patients observe and report their own behavior provides an even more efficient means for obtaining performance information.

To test the self-report method, ten SCI patients were asked to monitor various characteristics of their own behavior and to report these events chronologically to a researcher at the end of a 4.5 hour period. Other behavioral data were collected by two different methods which were used for evaluating the accuracy of the self reports. The first method relied on 90-minute observations which overlapped various parts of the client's reporting periods. The second independent measure of behavior was obtained from the rest time monitor. Each client was monitored five days a week for a consecutive two week period.

Why Get the Measures?: The concept and application in clinical practice of behavioral vital signs is crucial for comprehensive rehabilitation to become more effective, cost-effective, individualized, and based on rational principles. Three parts of our work will illustrate this point.

First, development of the concept of behavioral vital signs involves an important analogy with physiological vital signs such as temperature. One reason that traditional medical vital signs are

so diagnostically informative is that for each, there are well-established normative values or ranges. We are developing standard curves for behavioral vital signs.

Second, an important research question centers on the issue: why not have staff members rate the patients along requisite dimensions? We have tested this issue. Members of treatment teams rated whether patients were doing better (+), the same (0), or worse (-) than last week on three important behavior dimensions: (a) mobility, (b) diversity of activities, and (c) independence. Assessments were collected weekly throughout the hospital stays of five patients who were being observed concurrently by our research group.

Third, one of the most promising applications of the LFA approach is the ability to use the behavioral trajectory measured during hospitalization to predict individual functioning in the home and community environment. In preliminary analyses, nine performance measures were factor analyzed at two periods during hospitalization, the first three weeks out of bed and the last three weeks prior to discharge. The resulting factor scores were used as independent variables in a multiple regression procedure to predict three key aspects of patient functioning during follow-up.

Training: Training is an important methodological component of our overall LFA. Not only must we be able to use the tools of the LFA, but more importantly, we must be able to teach others to use them. For our narrative observation procedure and our standard note from observation, we have complete training materials available. These training packages also serve for the PAS. For the self-report procedure we have the supporting manuals in press, a series of training videotapes, and the supporting forms for data management and logistics. We are developing a videotape training procedure for the TSI.

Implementation of LFA Components: The primary task ahead for our project is to bring our methods and perspective into practice by clinical personnel at TIRR. As we develop and refine various component parts of our LFA, we will fit them into ongoing clinical activities and procedures. The STM has achieved application by the OT department on a reimbursement basis. We are working with the model SCI Center and TIRR's outpatient clinic to integrate the ENS and TSI into routine posthospital clinical practice.

We are beginning a research project in collaboration with the Physical Therapy department. One main thrust of this effort is to find ways to adapt our methods to suit the goals and objectives of the PT department.

FINDINGS TO DATE: What to Measure: The mapping analyses began with 215 variables measuring patient performance. An extensive correlation analysis reduced these to 42 measures. Applying the factor-cluster procedure to the set of 42 measures provides the first overall picture of the topology of the measurement domain. Based on the structure revealed in the mapping analysis, six measures were selected as behavioral vital signs. **Independence** represents the first major facet, behavioral dynamics. The second major facet is represented by the two instrumented measures, RTM (**time out of bed**) and the wheelchair odometer (**mobility**). The minor facet of **family involvement** is included. A measure of **activities in the ward** was selected as a vital sign. The **activity level** indicator serves as an aid in interpreting the other vital signs based on rate or percentage measures. Since it is the denominator in the equations for calculating the rates of independence, family involvement, and ward activity, the measure must be in the data system anyway.

How to Get the Measures: Before relying on the self-report procedure for gathering data on behavioral vital signs during hospitalization, we tested it against our proven procedures. In general, we find that the self-reports provide slightly less detailed accounts of the stream of behavior. One primary source of disagreement was the patient's failure in reporting brief idle periods. The self-report is practical for use by clinical staff; it provides a potentially cost-effective and time-efficient method for obtaining behavioral vital signs.

Why Get the Measures?: We have compared staff estimates of patient functional health status with our direct measures of patient functioning. Patterns of consensus between the ratings of treatment team members were identified and agreement levels between staff ratings and the observational records were examined. Treatment team members did not agree very well with each other nor with external measures of the same functional performance criteria they were rating. Team ratings were more inclined to rate positively and much less inclined to rate negatively than was warranted by direct measurement of behavioral variables.

Developing standard curves for the behavioral vital signs is an important step in our project work. In previous years we reported on a preliminary standard curve for the RTM. This standard curve is being used in treatment team chart round meetings. Preliminary normative curves have been developed for the behavioral vital signs and will continue to be developed.

In the area of outcome and prediction, we have preliminary prediction analyses based on 9 patients for which we have data on functional performance during both hospitalization and post-discharge periods. Using in-hospital performance data as the predictors (independent variables) we looked at three outcome measures (criterion or dependent variables). First, the rate of unscheduled readmissions to TIRR over an 18 month period following discharge represents an important outcome measure to service providers. The in-hospital performance indicators predicted 54% of the variance in this criterion variable. This is a predictive correlation of .74. Second, the in-hospital performance indicators accounted for just over 50% of the variance in overall independent functioning at three months postdischarge. The predictive correlation was .71. Finally, an in-hospital index of mobility predicted nearly 50% of the variance in the rate of conducting activities outside the home setting at three months postdischarge. This is a predictive correlation of .70.

An old adage in rehabilitation asserts that it is ability that counts, not disability. Another popular cliché states that past performance is the best predictor of future performance. The LFA approach to assessment and evaluation of functional health status combines the kernels of truth embodied in these two condensations of traditional wisdom.

APPLICABILITY: We anticipate two major sets of products from this project. The first will include a tested and demonstrated method for the longitudinal measurement of functional performance by persons with severe physical disabilities, as well as the supporting manuals, descriptions, and procedures for training users. The second set will include a general approach to research and problem definition in the area of human behavior, specific methods of data gathering, a clear set of strategies for progressing from general description to refinement and testing of hypotheses, a large, integrated set of findings regarding the behavioral aftermath of spinal cord injury, and some new conclusions regarding the structure of human performance.

Our perspective and our procedures have been somewhat new. However, they have been accepted by clinical staff and patients, probably because the principles of the LFA are seen to relate so directly to the central philosophical and pragmatic problems of rehabilitation: progress in functional performance and adjusting to the environment. We offer a conception of rehabilitation and a set of measurements around which patient programs can be unified and individualized. Our major purpose in this project is to test the extent to which this conception and the measurement procedures (the LFA) can be used by those responsible for delivering rehabilitative care to severely disabled persons.

089 Stereometric Analysis of Static Equilibrium in Patients with CNS Disorders

Principal Investigator:	R.E. Herron, Ph.D.	
Status:	Continuing	
Dates:	September 1977-September 1980	
Cost:	Annual \$52,106 RT Annual \$34,791	Projected Total \$131,000 RT % of Annual Total 67%
Annual Report Reference:	#17, Page A-254, R-177	

OBJECTIVES: The main purpose of this preliminary study is to explore the use of a newly developed bio-stereometric sensor as a means of recording "static" body balance of patients undergoing therapy for disorders of the central nervous system.

The original biostereometric sensor was selected for an IR-100 Award as one of the one hundred most significant technical developments of 1974. With support from the Rehabilitation Engineering Center program at TIRR several refinements in the design have been made to make it more suitable for use in studies of the disabled. The proposed study represents a continuation of our efforts to further develop and demonstrate the clinical potential of this novel instrumentation system.

METHODOLOGY: The study will be conducted in three phases. Phase I will involve the development of a test procedure for evaluating the static body balance of a seated individual and when the individual is standing upright with the aid of parallel bars. Different methods will be explored with a view towards establishing the best means of sensor orientation and attachment for obtaining a faithful record of the individual's body excursions (at the point of sensor attachment).

When Phase I has been satisfactorily accomplished, the procedure will be applied to a small sample of patients (5-10) undergoing treatment for CNS disorders in the TIRR physical therapy program (Phase II). In the standing test position, the patient's lower extremities will be braced or splinted if necessary. During this phase, we will focus primarily on two elements: (a) eliminating any remaining practical difficulties in the use of the sensor by clinical personnel, and (b) identifying output parameters that will be most meaningful to the therapist and clinician.

Phase III will involve increasing the size of the subject sample in an effort to systematically establish standards against which to measure the patient's performance. Additionally in Phase III refinements in data output, both numeric and graphic, will be made to increase ease of interpretation by the therapist.

The biostereometric sensor has been used successfully to record the ranges of motion of major joints of normal children and adults. The concept of direct stereometric motion recording has proved to be basically sound and recent modifications to the original sensor design should make the aforementioned application to the disabled subjects quite feasible. The present project is an exploratory one, and it is impossible to prescribe a highly rigorous experimental program since the successive steps are dependent on not-readily-definable preceding ones. This limitation seems to be inherent to the development of a test procedure which departs substantially from the state-of-the-art.

FINDINGS TO DATE: Research conducted during the current reporting period had produced results allowing for the completion of Phase II, as stated in the Methodology section of this report. Additionally, tasks necessary to meet the planned goals for Phase III were implemented. The first of the primary objectives to be accomplished in Phase II was the elimination of the remaining practical difficulties in the use of the sensor. To achieve this goal a new data acquisition system consisting of a three axis quantizer and cassette tape recorder was designed and fabricated. An instruction manual specific to data collection for this project was also produced. The advantage of this new system over the one previously used in Phase I lies in the fact that it is a dedicated system with fewer options and therefore simpler for clinical personnel to operate. Additionally, this system is significantly more compact and provides the portability necessary to collect data at a variety of clinical sites.

The second primary objective of Phase II (also a continuing investigation for the coming research period) has been the identification of the output parameters most descriptive of postural stability and more meaningful to the therapist and clinician. The Postural Stability Index (PSI) described in the Annual Report for the grant period 10-1-77 to 9-30-78, reflected a combination of features such as (1) the total excursion distance recorded during a test trial, (2) the maximum area of horizontal displacement of the trunk while the patient attempted to maintain balance; (3) a factor relating to the duration of the trial. The resultant PSI was therefore a single index reflecting the ability of a subject to maintain trunk equilibrium. Recently, however, a decision was made to study not only the changes in the PSI but also investigate individually the original components of the Index. Three additional parameters available from existing data are also being examined. These are: (1) rate of change in the excursion per unit time (cm/sec); (2) rate of change in the area of horizontal displacement per unit time (cm²/sec); (3) the linear distance from the sensor location (C-7) when the subject is in an "ideal" sitting or standing posture to the location of the sensor when all coordinates are averaged following the test trial. Ideally, as the subject improves in his efforts to maintain postural equilibrium, the values for all of these additional parameters will approach zero. By examining all parameters individually and not just in combination, a more definitive analysis of postural stability should be achieved.

Concurrent to the testing of patients, a sample (N=11) of normal subjects was tested using both the sitting and standing protocols. Subsequent analysis of the data indicated the presence of an error that was attributed to an electronic component failure in the quantizer during the time period when normal subjects were tested. Appropriate corrections were made and further testing of normal subjects will take place in Phase III to determine more accurate values for the objective

evaluation of subjects with Central Nervous System (CNS) injuries.

To date ten subjects with serious disorders of the CNS have been tested periodically in an attempt to record changes in postural equilibrium that can be correlated to their progress in physical therapy.

APPLICABILITY: A sensor capable of providing a continuous readout of the position of a selected point on the surface of a body part, thus providing a three-dimensional spatio-temporal analysis of an individual's equilibrium control functions, affords great potential for evaluating the motor status of patients with upper motor neuron lesions and for documenting their progress in a therapeutic program. Such records provide new data concerning the effects of CNS disorders on critical motor functions and the remedial effects of different treatment regimens.

The production of a "hard copy" record of a patient's progress in gaining improved motor control of body balance may also prove valuable in motivating the patient to maintain a cooperative attitude towards the treatment procedures.

More complete records of equilibrium control functions at various stages of CNS disorders would contribute to a better understanding of the natural history of problems affecting the central nervous system. Information of this type could have important implications for both clinical and research purposes in rehabilitation medicine.

090 Stereometric Measurement of Thoracolumbar Mobility in Scoliosis With and Without Fusion

Principal Investigator:	R.E. Herron, Ph.D.	
Status:	Continuing	
Dates:	September 1977-September 1980	
Cost:	Annual \$67,562 RT Annual \$34,168	Projected Total \$138,000 RT % of Annual Total 51%
Annual Report Reference:	#17, Page A-272, R-178	

OBJECTIVES: The purpose of the project is to explore the use of a stereometric range of motion sensor (ROMS) for evaluating the natural history of scoliosis with and without modification by spinal fusion. The mobility measurement is confined to the thoracolumbar region because the segment is most affected by the fusion process.

METHODOLOGY: The population sample for this exploratory study will be comprised of five normals, five scoliotic cases with spinal fusion and five scoliotic cases without spinal fusion. All subjects will be within the age range 12-18 years and be matched as closely as possible with regard to sex and age. If the initial examinations present no special problems, the sample size will be increased as far as time and other practical constraints permit.

A stereometric Range of Motion Sensor (ROMS) consisting of a lightweight rod and a set of electro-optical transducers interfaced to a storage device, will be used to record point locations in three-dimensional coordinate form.

The spinal orientation of each subject will be recorded in five positions: (1) neutral; (2) maximum lateral bending to the left; (3) maximum lateral bending to the right; (4) maximum flexion; and (5) maximum extension in the sagittal plane. The five tests will be performed according to the procedures outlined by the American Academy of Orthopedic Surgeons (1965). With the subject in position, the tip of the ROM sensor will be placed in contact with the spine at intervals along the entire spinal column. Control points will be recorded at the palpable limits of the spinal length at strategic landmarks, e.g., C1, T12 and S1. Additional points will be recorded between the control points, as close to identifiable vertebrae as possible. It is not essential that the intermediate points fall exactly on the vertebrae, because the ultimate aim is to characterize the orientation of the spine and its major segments as a whole. However, the feasibility of achieving close approximations of vertebral landmarks will be explored as part of this preliminary study.

Both graphical and numerical displays of the spinal orientation will be investigated in order to identify a simple and meaningful format suitable for clinical application.

The first phase of the project will be carried out during Year I. If the results are promising, the second phase will be devoted to a more tightly controlled experimental analysis, using larger subject samples, with a view toward obtaining a more representative statistically sound, data base. The ultimate aim is to generate functional standards which can be used routinely to evaluate the natural history of scoliosis and, perhaps, other spinal abnormalities.

FINDINGS TO DATE: Research conducted during the current year was primarily centered about the quantification of the three-dimensional geometry of the spine in a manner that would allow comparison of thoracolumbar mobility in normal subjects and those with abnormal spinal curvatures. In the previous year's report (10-1-77 to 9-1-78), it was reported that software was developed to express the spinal geometry by a single best fit polynomial (2nd order). However, further testing of both normal subjects and objects with fixed curvature demonstrates that a single polynomial equation would not adequately fit the shape of the spine. As a result of the finding, work was begun and is continuing into the next year of study that will enable the curve to be described by a series of piece-wise polynomial equations. Basically this technique requires the fitting of a curve by a second order (cubic) polynomial for every five data points collected.

The means of determining these series of equations and combining them to develop the description of a normal curvature would involve collection of data from a large number (N=100) of subjects. Plans have been formulated to test children between 8 to 16 years of age. Presently we have identified and begun the training of several graduate research assistants for Department of Physical Therapy at the Texas Women's University in Houston. These research assistants form the core for the data collection of both the three-dimensional coordinates describing the spine and a scoliosis screening examination (criterion). The testing phase will begin in September 1979.

Concurrent with the research assistant training program, data has been collected by four testers to determine both inter- and intra-tester reliability. The results of this phase will serve as a standard level of measurement accuracy for all the research assistants to achieve in operation of the data acquisition system.

Finally, a new data acquisition system consisting of a compact three axis quantizer and a data cassette recorder have been designed and fabricated in the past year. This activity allows for portability necessary to collect data at a variety of sites and therefore reduces the problem previously encountered in locating large numbers of normal subjects within the Texas Medical Center area.

APPLICABILITY: The improvement of methods for evaluating the natural history of severe disabilities is given a high rating (second order) in the recent documentation of RSA goals. It is our contention that the proposed method may offer a convenient, innocuous and comprehensive means of evaluating the effects of surgical intervention (fusion) on spinal mobility. It has the potential for making the evaluation of spinal mobility more objective, reliable and practicable than currently available methods. The apparatus is conceptually simple and a cost effective system based on modern electronic technology seems well within reach.

091 Cardiac Rehabilitation Program for Patients with Myocardial Ischemia and Arterial Hypertension

Principal Investigator:	D. Cardus, M.D.	
Status:	Continuing	
Dates:	September 1977-September 1980	
Cost:	Annual \$153,397 RT Annual \$128,738	Projected Total \$323,000 RT % of Annual Total 84%
Annual Report Reference:	#17, Page A-206, R-179	

OBJECTIVES:

1. To evaluate the effects of reconditioning exercise in patients who have both ischemic heart

disease and hypertension.

2. To identify criteria which could be used to select coronary and hypertensive patients for exercise training therapy as a major component of a cardiac rehabilitation program.

METHODOLOGY:

1. Subjects - the subjects will be males 30-60 years old subdivided into patients having (a) hypertension (diastolic pressure above 90mm Hg but below 130 mm Hg) without ischemic heart disease, (b) hypertension with ischemic heart disease (IHD) without previous myocardial infarction (MI) and (c) hypertension and having had a previous MI. Subjects in each group will be randomized into exercising and non-exercising sub-groups.
2. Plan - the study is to be developed in three phases: (1) patient recruitment, selection and preparation (12 months); (2) collection of data before, during and after the period of exercise training (24 months); (3) analysis of data and preparation of final report (6 months). Allowing for overlapping between the first and second phases, the project is planned to be carried out in three years.
3. Procedures - During the first phase, patients are screened for hypertension and ischemic heart disease. Hypertension is determined by measurements of blood pressure at rest in three occasions. In case of doubt, an additional cold pressure test is administered. The presence of ischemic heart disease is assessed by either documented myocardial infarction, a positive exercise test or evidence of coronary stenosis by coronary arteriography.
 - a. Pretraining evaluation. Once a patient is found to have hypertension and coronary heart disease, a pre-exercise training evaluation is conducted consisting of clinical and socio-economic interviews, a physical exam, an exercise stress test and determination of some blood components. These determinations will eliminate those patients who have clinical conditions for which exercise is clearly contraindicated or which might impair physical performance or interfere with the effects of an exercise training program. The hypertension will be treated in an attempt to reduce it to normal limits prior to initiating an exercise program.
 - b. Exercise training. This phase will consist of supervised exercise with a bicycle ergometer conducted in our laboratory. Exercise will be prescribed according to individual performance and conducted five days per week for 20 to 30 minutes at each session. Each subject will be in the program for three months.
 - c. Follow-up evaluation. Physical performance evaluation will be carried out at the end of the exercise training period and at three month intervals thereafter. Evaluation criteria will be based on changes in parameters derived from observations and measurements obtained of these studies.

FINDINGS TO DATE: Recruiting - A total of 82 tests were performed in the 13 months on which this report is based. All subjects studied were screened for participation in this project. First time studies were conducted on 50 persons of which 28 persons having historical evidence of hypertension were selectively recruited for this project. The remaining 32 studies were follow-up studies on subjects who had participated in previous projects. Half of these had presented clinical evidence of hypertension and repeat studies were performed to meet the requirements of this study. Direct recruiting for this project has been obtained by recalling patients seen in our laboratory who presented historical or clinical evidence of hypertension. Seventy-five letters were sent to reach new prospective subjects, 16 responses were obtained from which five persons were recruited for exercise phase of this program. Two entered the program and three are being further studied for hypertension in accordance with the protocol. Presentation of the program has been made to community and civic groups totaling more than 100 attendees. There has been no appreciable recruiting response to these presentations. Following effective control of their hypertension, nine patients have entered the reconditioning exercise phase of the program. Four have completed the exercise training, were retested, and are now on a prescribed home exercise program. Three patients temporarily dropped from the program and two more were unable to continue the program at this time for clinical reasons. The other patients having hypertension but not entering the exercise program are being followed as controls.

APPLICABILITY: The potential benefits of this project may take place in terms of: (a) an increase in the individual capacity for physical work which is generally severely affected in ischemic heart disease and hypertension; (b) reduction in the number of work days missed by shortening the time of recovery and the number of recurring episodes due to patient anxiety; (c) increasing the probability of the patient being able to return to his normal occupation; (d) reducing the cost of medical care by using a rehabilitative procedure (exercise) not as costly as others (medical treatment, coronary by-pass, etc); (e) the possibility of extending the use of the physical re-conditioning methods developed in this project to patients with other kinds of disabilities; and (f) a gain in the understanding of the multiple facets of ischemic heart disease and the possible rehabilitation approaches to the problems presented by the disease.

092 A Longitudinal Study of the Course of Vocational Development Following Severe Spinal Cord Injury

Principal Investigator: W. Alfred, M.A.
Status: Continuing
Dates: January 1978-January 1983
Cost: Annual \$33,273 Projected Total \$165,000
RT Annual \$24,899 RT % of Annual Total 75%
Annual Report Reference: #17, Page A-239, R-180

OBJECTIVES: The basic purpose of this project is to document the course of vocational development among SCI persons from the time shortly after onset of injury to two years post injury. Specific objectives are:

1. To determine what are the statistically documentable trends in vocational development among SCI persons during the prescribed period.
2. To assess how the vocational development of SCI individuals changes in its stability over time during the two years post injury.
3. To determine if trends in vocational development differ among groups of SCI persons according to differences in pre-injury level of vocational development, disability, kinds and degree of functional limitations, educational level, and age.
4. To determine if vocational outcomes among SCI individuals can be predicted in terms of vocational development observed during the two year course following injury.

METHODOLOGY:

1. **Subjects** - The subjects will be patients of the TIRR Regional Spinal Cord Center who have been admitted for comprehensive rehabilitation services no more than 90 days following injury. Each will have the provisional diagnosis of having sustained a spinal cord lesion (complete or incomplete) at a level ranging between C2, 3 to L5. The subject's minimum age will be 18; their sex, race, and education will not be used as criteria for admission into the study.

It is estimated that 35 to 45 subjects will be available for study over the entire two year period. Since some subjects will become unavailable for follow-up study, as many as possible (75-85) will be admitted initially into the project.

2. **Interviews and Scales** - Vocational Development will be measured using the Goldberg Scale of Vocational Development (GSVD). The pre and post injury sections of the GSVD will be administered to subjects during the interval between the time the patient is able to sustain vertical tolerance and prior to the medical prognosis conference. The post injury section of the GSVD will be repeated on a periodic basis at the following times:
 - a. after the medical prognosis conference but before hospital discharge;
 - b. during the first hospital readmission or first outpatient clinic visit occurring within a 2 to 6 month period after hospital discharge;
 - c. during the subsequent hospital readmission or outpatient clinic visit occurring within an interval of 10 to 14 months;

- d. during a hospital readmission or outpatient clinic visit occurring at the end of 2 years post-injury.

The Barthel Index, Manual Muscle Test, and Evaluation of Personal Independence Scale will be utilized to assess subject's functional abilities and to correlate with progress in vocational development. These scales will be administered during (a) and (b) as stated above.

3. Analysis of Data - The analysis of data will require:
 - a. establishing reliability of trained raters in scoring the GSVD;
 - b. correlational analysis to assess stability of the components of vocational development over time; and
 - c. correlational analysis of the relationship of post-impairment vocational development with pre-impairment development, type and level of injury, age, degree of personal independence and other demographic variables.

FINDINGS TO DATE: Satisfactory rater reliability in scoring the GSVD has been achieved. Ten SCI patients were admitted into the preparatory phase of the project which involved achieving rate reliability in scoring the GSVD. Since May 1, 1978, three SCI subjects have been admitted into the project for actual study. With two of the subjects the GSVD interviews have been administered prior to and after the medical prognosis conference. The third subject has had medical complications and has not yet achieved limited vertical tolerance.

As a result of an analysis of recent statistics on the SCI population at TIRR, a decision has been made to expand the study's admission criteria to (1) include patients admitted to TIRR within 90 days after onset of injury and (2) include patients with incomplete spinal cord lesions. This will allow for a broader based and more comprehensive study, particularly in analyzing the vocational development of persons with varying degrees of functional limitations as a result of spinal cord trauma and in comparing the vocational development process between those with complete and incomplete spinal cord lesion.

Since this modification of the study will require more accurate assessment of functional residuals among SCI patients, the Barthel Index scores will be supplemented by scores on the Manual Muscle Test (MMT) administered by the physical therapy staff, and by scores on the Evaluation of Personal Independence (EPI) administered by the occupational therapy staff. The MMT and EIP scores will be obtained twice: prior to first admission discharge and during the last hospitalization before the end of the 2 year post injury date.

APPLICABILITY: A key tenet of vocational rehabilitation practice is that the kinds of vocational services that are offered to clients must be finely tuned to the individual's readiness to participate actively in the rehabilitation process. In this study a serious attempt will be made to determine when vocational intervention should take place following SCI and to determine the content of vocational services which would be most meaningful to SCI clients at different junctures in their post-injury vocational development.

093 Evaluation of the Effects of Spinal Stimulation on Motor Performance in Patients with Upper Motor Neurone Lesions

Principal Investigator:	M. Dimitrijevic, M.D., D.Sc.	
Status:	New	
Dates:	September 1978-December 1981	
Cost:	Annual \$174,731 RT Annual \$65,928	Projected Total \$497,000 RT % of Annual Total 38%
Annual Report Reference:	#17, Page A-68, R-181	

OBJECTIVES: The objectives of this work are (a) to determine the degree to which clinically non-recognized but neurophysiologically detectable, residual functioning can be augmented with spinal stimulation in patients with upper motor neurone lesions, thereby resulting in improved motor performance, (b) to determine which categories of patients with upper motor neurone lesions

can be expected to benefit from this technique, not only M.S. patients but also those with paralysis or paresis due to spinal cord injury and Friedreich's ataxia, and (c) to determine what neurophysiological mechanisms are responsible for modification of residual spinal cord functioning during spinal stimulation to produce these beneficial clinical effects.

METHODOLOGY:

1. **Population Sample:** The subjects for this study will be those patients referred to the program of Restorative Neurology, Department of Clinical neurophysiology, TIRR for management of problems of spasticity and weakness or paralysis associated with upper motor neurone disorders due to multiple sclerosis, spinal cord injury, head injuries and Friedreich's ataxia. From this group approximately 20 will be selected for evaluation of the effects of spinal stimulation. The selection will be made on the basis of the clinical criteria that (1) the patient is suffering from a chronic, stabilized or slowly progressing neurological disorder with a predominant upper motoneuron defect, (2) there are no better alternative treatments available for the patient, (3) that the patient will be able to benefit from minimization of the motor defect in his/her activities of daily living.
2. **Experimental Plan:** This study will be divided into three phases. After the patient has been clinically evaluated and a clinical determination made that the patient is a suitable candidate for stimulation as described above, the first phase consisting of measurement of the neurophysiological profile of the patient's dysfunction will begin. This will include a kinesiological evaluation of gait and of the function of the upper limbs, of any defects in speech, and a neurophysiological evaluation of descending motor control functions by testing segmental reflexes and reflexes dependent on brain influence—postural reflexes, long loop reflexes and volitional control—using a polyelectromyographic recording technique. In addition, measurement of the status of the sensory system will be made, including somato-sensory evoked potentials. Each of these tests is conducted using non-invasive techniques.

Following the thorough clinical examination and neurophysiological measurements, and assuming that the patient fulfills the criteria above, the second phase, consisting of placing the epidural electrodes and monitoring the short term effects of spinal stimulation, will begin. Following receipt of patients informed consent, the electrodes are placed using Touhy needles inserted into the spinal canal in the epidural space above the dura, by passing the electrodes through the needles. The postelectrode placement period testing will be of the same nature and similar extent to that done pre-stimulation. As is done in routine clinical use, the continuous stimulation strength, frequency and pulse duration will be adjusted at a comfortable level for the patient. The shortest possible time consistent with adequate clinical and neurophysiological evaluation of the effects of stimulation, typically three days, will be used to determine whether or not the system should be permanently implanted in phase three. The neurophysiological measurements in this phase will be a subset of measurements used in phase one, selected according to the anticipated and observed effects of the percutaneous spinal stimulation.

If it is determined that the patient has received obvious clinical benefits from the stimulation and wishes to continue, a second consent will be obtained from the patient and the stimulation system will be implanted according to accepted surgical practice for such implants. Currently, the permanently implanted systems consist of an implanted receiver placed in a pocket under the skin on the patient's side, connected to the previously implanted electrodes via a subcutaneous tunnel. The electrodes are energized by placing a transmitting coil on the skin surface above the receiver, connected to a battery powered externally worn transmitter/generator. Future systems may employ a "permanent" totally implanted system with an average life of three to five years.

The surgical procedure for implanting the system is a routine procedure, employing the standard hardware, done under local anesthesia which is particularly important for the M.S. patients. The patients will again be monitored for long term effects using the same general procedures as outlined in phase one, and will be evaluated typically after three months, six months, and every six months thereafter unless some unusual results are obtained which necessitate more frequent monitoring.

Independent variables will include: (1) placement of the stimulating electrodes; (2) stimulating pulse frequency and duration; (3) fixed protocols for performing the individual tests.

The dependent variables will be: (1) intensity of spinal cord stimulation; (2) latency of onset of major effects; (3) persistence of effects; (4) carry-over effects following cessation of spinal cord stimulation; (5) changes in pattern of response to polyelectromyographic evaluation, to TT-TVR test, and to elicitation of spinal and cortical evoked potentials; (6) changes in functional performance of motor tasks representative of activities of daily living; (7) changes in temperature of the extremities; and (8) changes in the number and severity of handicaps as perceived by the patient.

FINDINGS TO DATE: During this initial project year, significant progress has been made toward meeting all three objectives. With completion of remodeling of the laboratory and installation of a new computer system, the quality and quantity of measurements have increased, through the resultant improvement in facilities, equipment and techniques.

As a consequence, more extensive neurophysiological evaluations can be carried out on a routine basis. During this year 19 patients have been selected for evaluation of the effects of spinal cord stimulation. From this group, 10 received significant benefits and subsequently elected, in consultation with the clinical staff, to have a system permanently implanted. Three were found to have insufficient improvement to warrant implantation, and the remainder are either still in evaluation of the effectiveness of stimulation or waiting for system implantation.

Through these preliminary studies, we have found that spinal cord stimulation will be effective if the patient's long loop reflexes are preserved. Two of the three patients who did not respond to spinal cord stimulation likewise did not show any neurophysiological evidence of preserved long loop pathways. (All 3 not responding were spinal cord injury patients, the third however, was a lumbar injury, the first such studied in our laboratory.) The stimulation studies were carried out in these two patients in spite of the lack of evidence of long loop pathways, since the reflex testing we use is not exhaustive, and it has not yet been shown that pathways which are so evaluated are identical to those involved in producing the beneficial effects of spinal cord stimulation.

In the work to date, we have divided the evaluation of the effects of spinal cord stimulation into a consideration of the immediate effects and the long-term changes with chronic stimulation. Immediate effects include: Sensory inputs consistently distinguishable in frequency and in amplitude, and the facilitatory effect on segmental stretch reflexes when applied in the correct time relationship. Evaluation of chronic stimulation effects revealed no profound changes in the character of evoked potentials or of segmental reflexes, but did show a marked decrease in the electromyographic features of spasticity and some evidence of increased suprasegmental control.

The clinical findings to date suggest that spinal cord stimulation is effective in controlling spasticity of brain stem origin, and that it can beneficially modify action tremor and ataxia. The effects of the stimulation can in some cases extend rostrally as well as caudally, resulting in improved speech production, and improved eye coordination and control as well.

Work on a model of the effects of spinal cord stimulation is continuing. At the present time, the working hypothesis is that the stimulation effects are indirect, primarily mediated via the dorsal columns and subsequent augmentation of suprasegmental function, resulting in at least partial restoration of brain influence on segmental reflexes.

APPLICABILITY: It is anticipated that there will be two primary types of beneficial effects of spinal stimulation on the patients. The first effect, which is now well documented for the M.S. patients, and has been observed in other patients as well, is the generalized improvement in volitional control of movement due to the facilitation provided by the constant stimulation. This effect has some carry-over, in that the patient's motor performance does not return to the prestimulation state for several hours to several days when the stimulation has been turned off after several weeks of stimulation. The second effect, which has been observed in several patients, including spinal cord and head injury, is the reduction of abnormal movements or spasms which in turn, permits fuller usage of residual motor performance of the patients. The use of this stimulation has been demonstrated to improve the quality of life of some patients with disease or injury of the central nervous system. The improvements in motor function lessen their dependence on others for care and thus reduce the cost of caring for them. Some can be expected to become independent and able to return to work.

094 Demonstration and Evaluation of a Model Surveillance System for Neurological Active Drugs Used in Spinal Cord Injured Patients

Principal Investigator:	L. Halstead, M.D.	
Status:	New	
Dates:	October 1978-October 1981	
Cost:	Annual \$28,318 RT Annual \$24,961	Projected Total \$93,000 RT % of Annual Total 88%
Annual Report Reference:	#17, Page A-82, R-182	

OBJECTIVES:

1. Develop the component parts of a model surveillance system for neurologically active drugs commonly used in spinal cord injured patients.
2. Implement the model surveillance system at TIRR's Regional Spinal Injury Center.
3. Evaluate the impact of the model surveillance system on health care providers and consumers.
4. Facilitate implementation and evaluation of the model surveillance system at other spinal cord injury centers.

METHODOLOGY: Components of the Model Surveillance System. Four major components to the model surveillance system for neurologically active drugs must be developed. The first component is a special drug code which can be applied to neurologically active drugs. A prototype of the code that has already been proposed by the principal investigator is called the TIRR Drug Code. Drugs are coded based on two considerations: (1) a drug's primary (intended) and secondary (unintended) effects, and (2) the final neuro-structure(s) by that drug.

A second component of the model surveillance system will be a handbook tentatively entitled, "Neuroactive Drugs and Spinal Cord Injury: A Guide for using Neurologically Active Medications in Spinal Cord Patients." This will contain a description of how the code was developed and how it can be applied to individual drugs. There will be a number of composite tables and lists that summarize the following information: (1) the active ingredients, their physiological effects and the TIRR Drug Code for 54 commonly prescribed agents; (2) a list of the most common clinical problems for which these 54 drugs are prescribed, with special precautions, cost information, and specification of drugs of first and second choice for each clinical problem; and (3) an index that provides a comprehensive "interaction reference" for each of the 54 drugs with respect to all of the other neurologically active drugs using the interaction classification adopted by Hansten (1975).

A third component of the model surveillance system will be the reduction and reproduction of the TIRR Drug Code on pocket-size laminated cards with appropriate color coding to indicate inhibition or stimulation to various receptor sites. The back of the card will contain a listing of the 54 most commonly used neurologically active drugs at the Institute and their TIRR Drug Codes (Halstead, Claus-Walker, and Hma, 1978).

The fourth component will be a drug profile sheet which will be placed at the front of each patient's medical chart. This form will list all medications that the patient is currently taking and a column will be provided where the drug code can be entered for neurologically active drugs. This sheet will be kept current every 10 days by the pharmacy staff and is intended to serve as a reminder of all those medications which have been prescribed and might produce adverse effects.

Dissemination: After the TIRR Drug Code is finalized, a preliminary draft of the handbook on "Neuroactive Drugs in Spinal Cord Injury" will be written by the co-investigators and reviewed by pharmacologists and paraplegists at the TIRR Regional Spinal Cord Center, Baylor College of Medicine and other regional spinal cord centers. When a version suitable for clinical use is completed, the handbook will be printed and made available for evaluation to nurses, physicians, and pharmacists at TIRR. Later, a revised version will also be made available for evaluation by patients and their families.

FINDINGS TO DATE: Considerable progress has been made over the past year in achieving this project's first objective, namely the development of four component parts of a model surveillance system for neurologically active drugs used in spinal cord injured patients. The first component in the proposed system is a drug code specifically designed for clinical use with neurologically active medications. In response to a number of suggestions and comments from medical students, residents and attending physicians at TIRR and other centers, the TIRR Drug Code described in last year's report was revised to make it easier to read and use. The new revised code retains the same coding rules as before.

The second component of the model surveillance system is a pocket sized, laminated card which shows the TIRR Drug Code on one side and, on the other side, a list of 54 most commonly used neurologically active drugs prescribed at the Institute with their codes. Several dozen of these cards were produced and distributed to health care professionals at TIRR and those attending presentations describing the Drug Code at several professional meetings.

Finally, the fourth component of the proposed system was intended to be a mechanism for the clinical application of the drug code in hospitalized patients. Ideally, such a mechanism would help the clinical staff identify drugs with neuro active components, provide a list of their codes, and alert them to possible adverse interactions. A drug profile sheet was suggested in the project proposal last year as one mechanism for accomplishing these objectives. Such a sheet was developed and tested on a pilot basis on one of the nursing stations at TIRR for three months during the past year.

APPLICABILITY: The model surveillance system is intended to provide a systematic approach to help organize and rationalize a large amount of information concerning neurologically active drugs used in the management of spinal cord injured patients. In the course of the rehabilitation program, spinal cord injured patients are frequently treated with multiple medications at the same time. Even for a knowledgeable and conscientious physician, nurse, pharmacist or patient, storing, organizing and analyzing the various combinations and ways these drugs might interact adversely is a mammoth task, and in many instances for practical purposes, an impossible one. The problem of adverse drug interactions is a major one in the treatment of many conditions. It is compounded in spinal cord injured persons for several reasons: there is severe impairment of normal nervous system mechanisms; a large number of drugs, many of which have a neuro-active component, are frequently taken at one time to manage a multiplicity of organ system dysfunctions; and medications are prescribed simultaneously and sometimes unknowingly by more than one physician. Finally, it is clear for many medications, and especially newer ones, that there is a large knowledge gap regarding their effects in spinal cord injured persons.

095 Development of an Optimal Discriminant Function for the Early Detection of Scoliosis

Principal Investigator:	R.E. Herron, Ph.D.	
Status:	Deferred	
Dates:	September 1975-November 1981	
Cost:	Annual \$4,203 RT Annual \$3,591	Projected Total \$29,700 RT % of Annual Total 85%
Annual Report Reference:	#17, Page A-249, B-161	

OBJECTIVES: The main objective of this research is to quantify the long-term changes in three-dimensional body geometry which accompany surgical treatment (Harrington rod procedure) of scoliosis. This represents a change in focus from our original objective which was prompted by staff changes and a growing clinical interest in non-invasive, stereometric documentation of the effects of surgical treatment on scoliosis.

METHODOLOGY: In a mathematical sense any surface of the human body can be considered as being comprised of an infinite number of points in three-dimensional space (or in four dimensions if we include the dimension of time). It is only necessary to locate enough of these points (distributed over the surface of the body) using Cartesian or other coordinate systems to quantify the extension of the body in space or space-time. The feasibility of doing this with the aid of specially designed

stereometric sensors (mechanical, electro-mechanical, optical, electro-optical and ultrasonic among others) has been clearly demonstrated (Herron, 1972). Using established techniques of biostereometric data acquisition, simultaneous reduction procedures which produce a spatial description of body configuration based on three-dimensional coordinates measured on the body surface. These procedures are routinely used to extract coordinates on the body surface with an accuracy of plus or minus 0.5 mm.

The coordinates serve as input to a digital computer which is programmed to output relevant information in the form of numerical or analog data. Routine analysis of point coordinate data from the stereopairs yields such whole body information as:

1. total body and volume distribution;
2. volume and volume distribution of body segments;
3. quantification of body surface and surface distribution;
4. cross-sectional and whole body centers of gravity.

In a sense, biostereometrics permits us to put the body form into the computer in all its geometric subtlety, where it can be thoroughly analyzed or used as a basis for calculating specific parameters.

Data on whole body geometry of scoliotics will be derived from 25 sets of anterior and posterior stereograms chosen from among 50 such sets taken pre- and post-operatively of patients presenting for surgical correction of spinal curvatures of the Foaden Orthopedic Center. Normative data will come from stereograms of comparable normal subjects.

Established standards of posing will be employed to minimize changes in body configuration due to postural variations. These standards will be tested for their applicability to scoliosis and an effort will be made to identify additional poses which will more clearly reveal the effects on body geometry of a spinal curvature.

The whole body data for each individual at the pre- and post-operative (six months and three years) examinations will form the basis for analyzing the changes in body geometry over time. Evaluation of such parameters as bilateral symmetry of volume and surface area, horizontal rotation of trunk segments and location of center of gravity will reveal the nature and extent of changes.

FINDINGS TO DATE: During the present reporting period, the three-year post-operative recording on the available scoliosis patients was completed. However, due to funding limitations, it was not possible to complete the (1) digitization of the records on the stereoplotter, (2) computer processing of the stereometric records to yield graphical and numerical outputs, and (3) analysis of the changes in body geometry over time as outlined in the methodology section.

In view of the inherent value of these longitudinal records and the unlikely prospect of obtaining additional RT funding for data analysis in the immediate future, we wish to defer completion of the project for at least one year. During this period additional funding will be sought from NIH and other sources and, hopefully, the remaining work on this unique data base can be carried out as planned.

APPLICABILITY: The incidence of idiopathic scoliosis among adolescent females is estimated at slightly over one percent (Baker and Zangger, 1970) with a rather lower incidence in young males. In the U.S., about 7,000 cases a year are treated with the Harrington rod procedure but the effects (of the procedure) on three-dimensional body geometry are not well documented. The present study will provide further information about the spatial changes in the form of the trunk at six months and three years after the operation. The new data should prove valuable to clinicians and researchers in their efforts to better understand and control the effects of surgical intervention in the treatment of scoliosis.

096 Cervical Spine Injuries from Recreation and Sports

Principal Investigator:	L.S. Kewairamani, M.D.	
Status:	Discontinued	
Dates:	September 1977-October 1980	
Cost:	Annual \$9,484 RT Annual \$7,286	Projected Total \$19,100 RT % of Annual Total 77%
Annual Report Reference:	#17, Page A-39, R-175	

OBJECTIVES:

1. To document from an orthopedic standpoint, the mechanism of injury to the spine in patients following sports and recreation related activities—diving, collision sports and gymnastics;
2. to document from a neurological standpoint the patterns of deficit and recovery;
3. to utilize the orthopedic and neurological data to develop neuro-radiological criteria for classification of these injuries;
4. to compare neurological return, hospital course in these patients and cost of medical care of operated versus conservatively treated groups of patients;
5. to identify possible preventive measures in an attempt to reduce the incidence and severity of injury to the spine; and
6. to identify possible preventive measures directed toward minimizing the post trauma complications.

METHODOLOGY: Overview - The design of the data recording forms for this study will be complementary with the protocols being utilized by the RSA-sponsored National Spinal Cord Injury Data Research Center which is associated with RSA's Model Demonstration Projects for Spinal Cord Regional Systems. Thus, it will be possible to relate the detailed orthopedic, neurologic, and radiographic findings that will be generated in this study to the relatively much less refined data being collected on a national scale in the Center's study. A dividend of this approach will be that the findings of this study will be potentially more amenable to generalization on a national scale.

It is intended that this investigation will be conducted in three phases: (1) retrospective analyses of the available data from two different spinal cord injury programs in this country; (2) the formulation, operationalization, and pilot testing of a prospectively oriented study to be conducted in the TIRR Regional Spinal Cord Center.

FINDINGS TO DATE: From exhaustive review of medical records of 314 patients admitted at the Institute for Rehabilitation and Research, it became obvious that the specific information needed in this project was fragmented and scattered throughout the medical records and that there was no consistency in recording neurological and radiological abnormalities. Pathomechanics of spinal cord injury were conspicuously missing. In an attempt to establish a consistent and reliable data base, the "Spinal Cord Injury Abstract Form" was developed. This form makes it possible to collect accurate data and it has a built-in check mechanism for inconsistencies. From this form, data can also be stored in and retrieved from the central computerized data base. During its earlier stages of evolution, the form was pretested on a smaller patient population, and it is ready for use now in all cervical spine injuries.

During this year, an additional 36 patients with acute cervical lesions from sports and recreation activities were analyzed, i.e., 26 from diving, 5 from football, 3 from wrestling, and 1 from trampoline. In the following paragraphs, a brief analysis of 187 diving injuries and 55 injuries due to collision sports is presented:

Diving Injuries: Of the 187 cases of spinal cord injuries due to diving 90% were males. Eighty-seven percent of the injuries occurred between the ages of 11-30 years. Thirty-five percent of the injuries occurred from diving into a river, 22% into pond, ditch, or canal, 16% into swimming pools and 13% into creeks and lakes. There was 60% of the patients with complete sensory and motor loss below the level of lesion. Ninety-seven percent of the patients were found to have radiographic evidence of osteoarticular injury. Based on the pre-established radiographic parameters for classification of

the mechanism of injury, 75% of the patients sustained ventroflexion rotation injury; 13% vertical loading; and 5% retroflexion injuries. In the remaining 7%, the mechanism of injury could not be satisfactorily classified. Most of the patients (93%) had noted immediate difficulty in breathing and were rescued by people standing nearby. Sixty-five percent of the patients reported that they had under-estimated the depth of the water, although evidence of direct trauma to the skull was present in less than 7% of the patients.

Collision sports: There were 55 patients with cervical spinal cord injury secondary to collision sports—46 were injured in football and 9 in wrestling and boxing. All patients were male, and 70% were 16-20 years of age. Approximately 80% of the patients had a neurological picture of complete transverse myelopathy; 10% were central cervical cord syndrome, 7% anterior cervical cord syndrome, and 3% incomplete transverse myelopathy. Radiological evidence of osteo-articular trauma was present in 93%.

Although the principal investigator had relocated, the "Spinal Cord Injury Abstract Form" that was developed will continue to be used in the prospective study of cervical spine injuries resulting from sports and recreation activities to be conducted at the Louisiana Rehabilitation Institute.

APPLICABILITY: Systematic analysis of the mechanism of injury, patterns of neurological deficit and recovery along with the comparison of the methods of treatment (operative versus non-operative) in each group of patients included in this study will help in:

1. predicting the outcome of treatment much more accurately;
2. choosing the appropriate method of treatment likely to cause minimum complications and expedite rehabilitation of patients admitted in a comprehensive rehabilitation program; and
3. developing possible methods to reduce the incident and severity of injury to the spine from recreation and sports. The protective equipment will be evaluated in the light of this new knowledge in an attempt to minimize the injury from collision sports.



**Emory University (RT-6)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Medical

The etiology, natural history and the effects of various approaches to management of neuromuscular skeletal disorders.

Psychosocial

The effects of societal influences on neuromuscular skeletal disorders and the modification of these influences to reduce disability.

Vocational Rehabilitation

Those factors which influence vocational achievement and modify those factors to increase productivity.

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COMPLETED

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Emory University

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Developing Specific Treatment Strategies for Muscle Biofeedback in Stroke Patients

Evaluation and Restoration of Function in the Hemiparetic Upper Extremitiy through EMG Feedback within Patterns of Movement

The Development of a Systematic Approach to the Selection and Vocational Rehabilitation of the Severely Disabled

097 Evaluation of Exercise after Myocardial Infarction - National Exercise and Heart Disease Project (NEHDP)

Principal Investigator: S.B. Chyatte, M.D.
Status: Completed
Dates: June 1972-November 1979
Cost: Annual \$112,000
Annual Report Reference: #14, Page 84, R-42

OBJECTIVES: To determine in patients with CHD:

1. The effects of the exercise program on cardiovascular response measured by electrocardiographic responses, heart rate and blood pressure, physical work capacity, myocardial energy requirements and systolic time intervals (STI).
2. The effect of the exercise program on social and vocational psychological adaptation.
3. The operational problems of a long-term physical activity program.
4. The effect of the exercise program on mortality rate, recurrent MI, and occurrence of complications of CHD such as angina pectoris, dysrhythmia and congestive heart failure (CHF).
5. The prognostic implication and value of resting and exercise ECG abnormalities in patients with MI.
6. These behavioral and psychological characteristics which are important to adherence and non-adherence in long-term physical activity program.
7. The effect of different personality traits and social characteristics on psychosocial adjustment to an MI.
8. The effect on the level of plasma cholesterol and triglycerides.

METHODOLOGY:

1. Participants tested semiannually.
2. Each participant completed an informed consent, a cardiovascular history, physical exam, before each multistage exercise test (MSET).
3. MSET was graduated progressively, designed to indicate roughly the O₂ consumption of the patient at work and at rest.
4. Each stage was recorded as a 12 lead ECG with the XYZ scallar leads during the last 40 seconds of each stage.
5. MSETS began with supine rest, STIS, and standing rest; exercises stages were completed with STIS and two supine recordings.
6. Written psychosocial measures to assess anxiety and depression levels were administered at various intervals.
7. Cholesterol and triglyceride levels were measured and analyzed annually.
8. Follow-up of all participants ceased May 31, 1979.

FINDINGS TO DATE: As this study is a long-term and ongoing study, there has been no complete compilation of data by the Coordinating Center in Washington. At the conclusion of the project in 1980 a conference/symposium will be held to compile data results and decide on a dissemination plan for that data.

As of February 1, 1977, the Emory University Collaborating Center of the NEHDP had randomized 150 patients. The five collaborating centers of NEHDP have a total of 649 patients under study.

Compilation and analysis of data by the coordinating center in Washington continues; the role of Emory University in this national multi-center study is completed. As an eventual endpoint, the NEHDP will have a conference/symposium to compile data results and decide on the concluding dissemination plan.

APPLICABILITY: If the basic objectives of the NEHDP are proven positive in the rehabilitation of MI victims the project could be of great benefit if introduced into the Vocational Rehabilitation Program of all states. Last year alone in the United States 29,270,000 Americans were stricken with some form of heart or blood vessel disease. Cooperation with the State Division of Vocational Rehabilitation in identifying potential clients for a program modeled after the NEHDP will be very important in returning patients to their prior productivity and useful place in the community.

098 Cognitive Assist in Motor Learning

Principal Investigator:	Carmella Gornella, Ph.D.
Status:	Completed
Dates:	Completion: September 1978
Cost:	Annual \$16,907 RT Annual \$16,907 Projected Total \$30,000 RT % of Annual Total 100%
Annual Report Reference:	#14, Page 87, R-45

OBJECTIVES: To assess the effectiveness of video-tape self-instruction in the first stages of acquiring a physical skill (cognitive perceptual).

METHODOLOGY:

1. The rehabilitation skill learned was the three point crutch gait with one extremity non-weight bearing. The cognitive aspects of the skill were presented through a subject controlled audiovisual film simulation matched to the subject's sex and involved extremity. The testing of the effectiveness of the learning phase was through the performance of the skill without further instruction.
2. Performance in the motor task was measured by: (1) cognitive recall of the components of the skill as presented audiovisually; (2) spatial temporal analysis of a subject's filmed crutch gait sequence; (3) clinical rating of the subject's crutch gait performance.
3. **Design:** Since the question was delimited to the effectiveness, if any, of this teaching-learning strategy, a post-test control group only design was used. Subjects (N=20) were working women, volunteers ranging in age from 36 to 60 ($\bar{x}$ 49.65, SD 7.36). One-half of the group was randomly assigned to take the cognitive test after viewing the film but **before** walking with crutches; they are identified hereafter as Cognitive Pre Gait. The other half took the test also after the film and **after** walking with crutches and they are labeled Cognitive Post Gait. The group difference in age (Cognitive Pre Gait $\bar{x}$ =48.20; S=8.52) (Cognitive Post Gait $\bar{x}$ =51.10; S=5.69) was not statistically significant.
4. Measures included: Subject's perception of motor ability, cognitive recall of task elements, and actual motor performance.
5. Subject's reaction to film presentation was also elicited.
6. A second study was completed comparing the ability to do the task without any instruction versus instruction through the video-tape. As indicated by the performance of the group who walked twice before viewing the film, the average subject without other related problems of the patient can perform a crutch gait without the intervention of self-instruction. The difference that the instructional task appeared to make with this sample was the difference in numbers who achieved criterion 1 (i.e., keeping the head up—that is looking ahead).

This criterion of keeping the head up may be a characteristic of the later stages of learning in which performance is being shifted from conscious to automatic control. As kinesthetic control takes over, as it does in the later stages of learning, the learner may then attend to other stimuli. If there is any merit to this line of thinking, we can say then that the video-tape instruction followed by several practice trials was more effective than no instruction. With instruction, the difference

appears to be in the quality of performance and the quickness with which a subject moves from one stage of learning to the next.

Across the two studies, the two criteria most difficult for the subjects were the first, keeping the head up and the fifth, stepping through with a non-injured extremity. The meaning of the findings on the first criterion has already been discussed above. Of the elements involved in meeting the fifth criterion, the most critical is the sense of balance. In the normal subject, three practice trials were sufficient to show marked improvement. In the more apprehensive patient, more practice trials may well be necessary. The patient fearful of his or her sense of balance; but as this study shows, the patient may not need separate exercise to improve balance.

FINDINGS TO DATE: Group Characteristics: Although the two groups, Cognitive Pre Gait and Cognitive Post Gait did not differ significantly in age, they did differ along other dimensions. In comparison with the Cognitive Post Gait groups, the Cognitive Pre Gait group were more active currently with half of them having been even more active within the past three years; and they also perceived themselves as motorially more capable ranging from average to excellent. In the latter, the Cognitive Post Gait group showed a "normal" distribution from above average to fair.

Performance in Cognitive Recall: All subjects but one answered the questions correctly. The last subject of the day missed one of the questions. Otherwise, the groups learned equally well from the film.

Subjects were asked also about the clarity of the film and the sufficiency of information after they attempted walking with crutches. All responded favorably. Filmed performance not yet analyzed.

Our subjective impression is that at least 75% of the participants performed adequately. When difficulties were encountered, persons were either obese (≥ 165 lbs.) and could not lift their body weight, or persons had expressed doubts about their ability and in fact also appeared to do less well than the others. Data from Study 2 now being analyzed.

APPLICABILITY: A teaching learning model of a rehabilitation task under patient control is available which can accelerate patient rehabilitation, saving costs to the patient and time for both patient and health practitioners. The results will also make available an alternative mode of patient teaching learning as an illustrative example in the allied health curricula and to current practitioners.

Further testing of this alternative strategy to patient learning in motor skills will be conducted in clinical field trials in a new project which has been proposed and approved.

099 Clinical Field Trials of the Emory Detachable Electric Powered Drive for the Standard Wheelchair

Principal Investigator:	Carmella Gonnella, Ph.D.	
Status:	Completed	
Dates:	August 1974-April 1977	
Cost:	Annual \$9,929 RT Annual \$5,850	Projected Total \$30,000 RT % of Annual Total 62%
Annual Report Reference:	#14, Page 214, R-54	

OBJECTIVES: To measure the effectiveness of a detachable power unit for the standard wheelchair for patients with varying degrees of strength in the upper extremities and under a variety of conditions.

In developing a detachable motor drive for a standard wheelchair, numerous design criteria were considered. The objective of the last phase of this research was to make the current powered drive unit completely attachable/detachable solely by the wheelchair client.

In addition the current unit was taken to another R&T Center for additional field testing.

METHODOLOGY: The Biomedical Engineering Staff of EURR&TC and the Mechanical Engineering Department at Georgia Institute of Technology collaborated over an extensive three months to develop a user connectability mechanism for the existing drive unit. In the following two-month period (January-February, 1977) the completed drive units were taken to George Washington University.

Emory University

School of Medicine, Rehabilitation Engineering Center (Callif Mallik, Director) for additional field testing and evaluation.

Additional testing was done locally at the Georgia Institute of Technology Architectural Engineering Pedestrian Research Laboratory. This lab consists of numerous ramps and runways designed specifically for wheelchair testing. Use of their testing procedures enabled evaluation of the present drive unit in comparison with other commercial units.

FINDINGS TO DATE: Odometers attached to patient/client wheelchairs to determine miles traveled in their present chairs showed that a maximum of 13 miles per week with about 2.5 miles per work day. The Emory Detachable Unit has been found to do 10 miles on a single charge of the battery in initial testing. It also meets all criteria on climbing and descending inclines, turning radius, speed and ease of control.

Three phases were used to test efficiency and dependability of the Emory Unit. The initial phase consisted of trials within the Rehabilitation Research and Training Center (Morris, Gonnella & Cohen, 1976). A second phase consisted of field testing in various hospitals and health care facilities within the Atlanta area. The final phase of testing and evaluation of the Unit was its use by selected patients in their daily lives, be it at work or in a home environment (Morris, Cohen & Gonnella, 1975).

Several hospitals affiliated with the Emory University School of Medicine tested the unit. This testing provided us with information which was used in further refining and developing the Emory University Drive Unit.

The unit tested by Emory fits the adult narrow E&J wheelchair. Its modification to fit the adult medium chair in the field testing at George Washington was not effective and multiple problems were experienced. During a variety of tests on the chair with different clients, the George Washington staff noted that repairs or adjustments were necessary with some of the mechanical linkages within the power drive unit. Mechanical failures seemed to plague the testing protocol. Most of the problems, however, appeared to be caused by the necessity to modify the unit to fit larger wheelchairs; the latching mechanism as well as the joy stick control, would have to be modified so that they too would fit appropriately. At this point, field testing was terminated.

Several alternatives existed at that stage of the testing. Since most of the problems encountered in the most recent testing of the chair were mechanical in nature, these problems would be totally alleviated in a final design and blueprinting necessary for production. Another possibility is to identify all of the various problems with the unit, and adapt the unit to work with the three basic sizes of adult chairs. This approach would undoubtedly involve considerable time and some expenditures, at least another year would be required to complete this aspect of the project. The third alternative is to totally redesign the existing drive unit so that it is easily adaptable for all basic sizes of chairs. This alternative would involve considerably more time and money than the second but would undoubtedly represent a good quality device with widespread usage. Obviously, the final alternative is to leave the unit as is and report on its potential for future research. Because of the continued interest in this project by other centers and individual clients, we have decided to make the unit and the blueprints available to other centers. One such unit is now at the center at New York University; a second is at the Drexel University in Philadelphia. The blueprints will also be made available to interested manufacturers.

APPLICABILITY: This unit will benefit a population of wheelchair users who could benefit from an easily detachable and attachable unit under their control that would convert a standard wheelchair into an electrical powered wheelchair. Advantages are: increased mobility because of the portability of the standard wheelchair; better use of a client's available energy; potentially less cost than the standard powered unit currently available.

Patient-client self-initiating power needs to be conserved and reserved for activities more self-sustaining than the act of transporting oneself. Wheeling oneself is a demanding task. The availability in cost and ease of the detachable power unit for the standard chair can significantly affect the patient-client mobility and ability to care for oneself, hold a job, enjoy life without a constant physical drain.

100 The Use of Motor Unit Potentials as a Measure of Neuromuscular Integrity

Principal Investigator: Steven L. Wolf, Ph.D., R.P.T.
Status: Completed
Dates: October 1975-September 1977
Cost: Not applicable
Annual Report Reference: #14, Page 219, R-55

OBJECTIVES:

1. Determine the motor unit distribution in an ulnar nerve innervated muscle (first dorsal interosseous) of the hand in normal subjects (quantifiable as the total number).
2. To make similar determinations in patients with disease processes of the central or peripheral nervous system (multiple sclerosis, muscular dystrophy, myasthenia gravis).

Hypotheses:

1. The total number of motor units will decrease with age in a normal population.
2. Patients with disease processes of muscle (e.g., muscular dystrophy) will show insignificant changes in total motor unit number with age, while those afflicted with disease affecting primarily nerve (e.g., myasthenia gravis, multiple sclerosis) will show significant changes.
3. Changes in motor unit determination for patients will reflect the state of neuromuscular integrity (i.e., decreases over time suggest deterioration).

METHODOLOGY: Electrical stimuli were delivered to the ulnar nerve at the wrist using a TECA chronaximeter constant current source. Stimuli were delivered once a second in trains of four, repeated five times. This evoked response was shown on a Digiview plasma display. Pulse durations were set at .5 milliseconds and the stimulus intensity was progressively increased to supra-maximal stimulation levels in order to recruit subsequent motor units. The computer program, designed by Mr. Harold Clifford, employed a PDP8/E computer. The computer program permitted a quantitative determination of the total motor units in the first dorsal interosseous muscle. An output voltage proportional to the displayed muscle signal was fed into the analog to digital converter of the computer. The oscilloscope sweep and the stimulator were triggered simultaneously by a clock generator. Data processing was performed on line. The real time clock was triggered after a determined delay by the pulse from the clock generator. Sampling time required was determined by the duration of the longest muscle potential. The computer was capable of storing in memory many potentials, each of which differed in the latency, amplitude, duration or wave form from its predecessor, and each was evoked by progressively increasing the stimulus to the nerve. These memory stores are referred to as templates. After many templates had been stored, a supra-maximal evoked muscle action potential was sampled and stored in the final template. The absolute area in each template was derived. The number of motor units was calculated by the computer from the formula: $n = \frac{A(n)}{A(\max)}$ where n is a number of motor unit potentials in the penultimate template, $A(\max)$ is the absolute area of the supra-maximal evoked muscle potential, and $A(n)$ is the absolute area of the potential composed of n units. Electrodes, appropriate for recording evoked muscle potential, were constructed based upon histochemically determined n plate locations (see below).

Originally, we had intended to gather data from normal individuals, and patients with a diagnosis of muscular dystrophy, myasthenia gravis, or multiple sclerosis. Due to the problems noted below, we felt that sampling of motor unit determinations in patients was not necessary.

FINDINGS TO DATE: The computer program allowed us to sample the voltage components of the motor unit potential at more precise time intervals than had previously been reported.

To improve electrode skin contact, several types of electrodes were used. The best electrode configuration involved use of either point-on silver or silver plate electrodes which had been cut to conform to the first dorsal interosseous muscle contour. In both cases, we discovered that changes in skin electrode impedance over time contributed greatly to changes given stimulus intensity delivered to the ulnar nerve at the elbow.

Based upon preliminary sampling, using normal subjects we must conclude that the quantification of motor unit or any of their characteristics can be greatly compromised by the failure of the investigator to rigidly check and note the adherence of the recording electrode to the skin surface at any phase of the recording experiment.

To minimize the occurrence of this problem, we then resorted to the use of paint-on skin electrodes. By using paint-on electrodes, we felt that any problem attributable to changes in skin electrode impedance might be minimized. We were disappointed that the outcome of such attempts failed to greatly change the picture. Attempts to contact Drs. Ballantyne and Hansen in England to clarify our problems resulted in failure. Additionally, we contacted Dr. McComas at McMaster University in Hamilton, Ontario. He confirmed the reality of our problems and told us that in his attempts to determine motor units by recording all parameters (duration, peak to peak amplitude, surface area beneath the evoked potential) he met with similar technical problems.

One must conclude from these experiments in normal muscle, with the technical problems encountered in examining motor unit populations and responses to electrical stimulation of the appropriate nerve, considerable intra-subject variability can occur. As a result, one must question the efficacy and accuracy of the use of this technique as an electrophysiological diagnostic aid.

APPLICABILITY: In light of the difficulties in executing this project, we believe that computer-based motor unit determination methods are unreliable as an adjunct to assisting the clinician in evaluating the neuromuscular status of patients.

101 A Re-evaluation of Sensory Testing in Neurological Patients

Principal Investigator:	Steven L. Wolf, Ph.D., R.P.T.
Status:	Completed
Date:	September 1977
Cost:	Not applicable
Annual Report Reference:	#14, Page 225, R-56

OBJECTIVES:

1. To determine the existence of a relationship between sensory conduction velocities (measured as meters per second) and the patient's objective perception of cutaneous sensation (measured in mmHG for pressure, mm for two point discrimination and milliamperes for electrical stimulation) in cases of pathology affecting the peripheral nervous system.
 - a. To compare sensibility in the normal and affected limb using the above measuring techniques.
 - b. To compare sensibility in the affected limb before and after administration of a statement designed to change the attitude of the patient toward his perception.
 - c. To compare values of these measurements over time.
2. To determine the facility with which this technique can be employed by teaching paramedical (e.g. physical therapists, occupational therapists) to administer the procedure.
3. To determine whether the information generated from data analysis is of assistance to physicians and vocational rehabilitation personnel in facilitating employability of the patient population.

METHODOLOGY: The patients were seen on a regular basis for sensory conduction velocity determinations and sensibility testing. Initially, sensory conduction velocities were determined for the affected nerve and its contralateral counterpart. conduction velocities were performed using conventional clinical techniques. Information on these conduction velocities was photographed off a TECA-B electromyograph oscilloscope screen with a mounted Polaroid camera. Stimulation was provided by TECA ring electrodes at the digits or by TECA bipolar stimulating electrodes more proximally. Recording electrodes (Beckman discs) were placed over the appropriate nerve with a ground plate located over bony prominence between the stimulating and recording sites. The distance between these sites was measured with a tape measure and latency was read from the photographic picture. The sensory measurements included perception of pressure, electrical

stimulation of the digit to threshold and discomfort, and two-point discrimination. Pressure stimuli were delivered to an appropriate skin site in the hand, using a Grass FT-03 pressure transducer with linear calibration from 0 to 500 grams. Electrical stimuli were delivered from a constant current TECA chronaximeter and read as milliamps of current delivered to the digit. Two-point discrimination measurements were made at the distal palmar crease and the fingertip using a Preston anesthesiometer. Measurements for two-point discrimination were read in millimeters as the minimal distance between two points reliably perceived by the patient. Patients were prevented from seeing the presentation of stimuli by a partition placed between the investigator and them. No audio cues were available to the patient, as well.

From our initial studies on over 70 normal subjects, it was determined that the reading of the sensitization statement resulted in significantly greater reductions in threshold values than under control circumstances. The sensitization statement read to patients was the following:

"Our previous research shows that after applying pressure or electricity to your skin your ability to feel these sensations should be affected. Since you now have had the experience of knowing what the pressure or electrical pulse on your skin feels like, you should now be able to feel them more clearly. We are particularly interested in knowing how soon you can feel them, and how strongly each stimulus can be applied to your skin."

No attempt was made to develop a profile or scale for rating the attitudinal component of the sensory experiences. As promised in the original proposal, more than 20 patients were examined during the course of this study. Furthermore, the study clearly demonstrated that physician, therapist, and vocational rehabilitation counselor cooperative efforts could be obtained in determining the final disposition of peripheral nerve injured patients.

FINDINGS TO DATE: Twenty-five patients were seen at the Grady Memorial Hospital. All of these patients have been rehabilitated; they have either gone through a vocational rehabilitation program and are now employed, returned to school, or to their previous job. Vocational rehabilitation personnel became involved in the study and served as excellent liaisons in providing total rehabilitation care for these patients. The sensitization statement appeared to play no significant role in the change of sensory status. The amount of change following sensitization statements read at each session was not greater in the affected limb than in the control limb; however, there was a return toward control values in the affected limb over time. Of significance was the fact that these changes appeared to precede return of normal sensory conduction velocity values. In several of our patients, two-point discrimination at the fingertip had not returned despite the fact that they had spent as much as two years in the program. Perhaps the most significant aspect of this work was a realization that because patients played an active rather than a passive role in the sensibility evaluation, they much more readily endorsed the notion of total rehabilitation.

APPLICABILITY: By including objective measurements of sensory return as part of the evaluation process, a clear and more definitive decision can be made regarding the disposition of patients with peripheral nerve lesions. Invariably these lesions are the result of trauma or vocational accidents. As a result, particularly in lower income clients, the motivation for compensation appears to be quite great. As a result, the potential for working productivity of these individuals may be retarded. By actively involving patients in the evaluation process over time, the motivation for cooperative and productive effort seems to be improved. These clients present to vocational rehabilitation counselors with higher estimates for their working potential. No longer should it be necessary to rely exclusively upon conduction velocity determinations as the primary factor in evaluating the disposition of peripheral nerve injured patients, since it has been demonstrated that this measurement lacks the sophistication to truly assess change in upper extremity sensation. It is suggested that medical personnel working to employ this technique consider recruiting the efforts of a vocational rehabilitation counselor early in the evaluation process, and acquainting such personnel with the potential outcomes of the technique.

102 Measurement Correlates in Chronic Low Back Pain; EMG Studies, Personality Profiles, Functional Performances, and Their Changes Following Sympathetic Blocks

Principal Investigators: Steven F. Brena, M.D.
Steven L. Wolf, Ph.D., R.P.T.

Status: Completed

Dates: November 1976-October 1977

Cost: Annual \$24,482 Projected Total \$24,482
RT Annual \$8,609 RT % of Annual Total 35.5%

Annual Report Reference: #14, Page 29, R-60

OBJECTIVES: To determine the effectiveness of lumbar sympathetic blockade in alleviating chronic low back pain without accompanying physical rehabilitation by:

1. Monitoring paravertebral muscle activity before, during and following sympathetic blockade and placebo (measured in quantifying units following analog to digital conversion of electromyographic data from low back musculature; angular degrees of change in back and hip mobility evaluated as trunk flexion over hip and straight leg raising);
2. Examining personality profiles before and following lumbar sympathetic blockade and placebo (administration of the Minnesota Multiphasic Personality Inventory (MMPI) measured in numerical units as a standard deviation);
3. Correlating changes in personality or neuromuscular states with objective functional improvement following block therapy and placebo (analysis of measurements stated in (1) and (2) to which is added a patient self-evaluation, UPTIME, defined as the amount of time that the patient spends standing per week as measured in hours).

METHODOLOGY: Patients are assigned randomly to one of two conditions initially in a cross-over design: (1) six sympathetic blocks over a two week period (three injections/week); and (2) six placebo blocks over a two week period (three injections/week). Psychogalvanic measurements are taken at all six sessions for each treatment condition. Other data being collected before and after the first treatment and after subsequent treatment sessions include: EMG and joint range of motion. MMPI information is obtained before first treatment and following the 12th treatment, one and three months after the last treatment.

FINDINGS TO DATE: Evaluation of mobility measurements, electromyographic activity, and psychological profiles over the four month course of this study and 20 chronic low back pain patients (10 surgical and 10 non-surgical) to complete their parts in the study have been compiled. The results of an analysis of these data may be described as follows:

1. Injection with Marcaine or saline cannot be differentiated clearly with respect to either short- or long-term pain relief.
2. Evaluation of pain intensity ratings at three month follow-up shows that 8 out of 18 patients reported at least 40% reduction in subjective pain. Initial MMPI profiles did not reflect the degrees of subjective pain relief.
3. While no significant changes in EMG could be measured, some patients did show marked improvement in mobility.
4. In patients showing improved mobility, reports of pain intensity decreased correspondingly.
5. Even in those patients showing improved mobility, functional activity levels did not increase significantly.
6. It would appear that additional psychological and physical therapies should be evaluated for their effectiveness in reducing the chronic low-back pain state.

The only element not included in our pain management regime was the behavior modification component. Contingency management is often an integral part of the process which enables patients to cope with their pain state. It would appear, therefore, that if lumbar sympathetic

blocks are successful in enabling patients to improve in their pain conditions then the behavioral management accompanying these blocks must play a vital role. The data from this study on chronic low back pain would suggest that additional forms of physical and pharmacological therapy would be worthwhile pursuing in an attempt to manage this type of patient. With this possibility in mind we have formulated a proposal (See New Proposals, P-3) which we believe will prove beneficial in managing patients with chronic low back pain. EMG biofeedback, while used primarily as a method to induce reductions in stress and tension levels of chronic low back pain patients, may also prove valuable in re-educating back musculature and hence disrupting the pain cycle. A primary drawback to the pharmacological block technique employed in the present study is that it is an invasive procedure. Muscle biofeedback, on the other hand, is non-invasive and may prove financially beneficial when the cost of compensating chronic low back pain clients is considered.

The findings from the study and their implications in the management of chronic low back pain will be presented at future RT-6 training courses as well as in courses sponsored by the Pain Control Center, Department of Rehabilitation Medicine, Emory University School of Medicine. In addition, information has been disseminated in the following manner:

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| Woff, S.L. | Mobility and EMG Assessment in Chronic Low Back Pain. Paper presented at the Second Annual Pain Symposium, Emory University, Atlanta, Georgia; May 4, 1978. |
| Woff, S.L. | Biofeedback Workshop, Baylor University Medical Center, Dallas, Texas; May 5-6, 1978. |
| Woff, S.L. | Biofeedback Workshop, Alabama Chapter of the American Physical Therapy Association, Birmingham, Alabama; May 20, 1978. |
| Brena, S.F., Woff, S.L.,
Chapman, S. and
Hammond, W. | Chronic Back Pain: Electromyographic, Motion and Behavioral Assessments Following Sympathetic Nerve Blocks and Placebos. Poster Session presented at Second World Congress on Pain, Montreal, Quebec, Canada; August 22, 1978. |
| Woff, S.L. | Biofeedback Symposium, Autogenic Systems, Inc., San Francisco, California; September 28, 1978. |
| Woff, S.L. | EMG Biofeedback Applications in Physical Therapy, presented to Connecticut Chapter of the American Physical Therapy Association, Meriden, Connecticut; November 4, 1978. |
| Woff, S.L. | EMG Biofeedback Workshop, RT-6, Atlanta, Georgia; October 24-27, 1978. |
| Brena, S.F., Woff, S.L.,
Chapman, S. and
Hammond, W. | Chronic Back Pain: Electromyographic Motion and Behavioral Assessments Following Sympathetic Nerve Blocks and Placebos. Poster Session presented to American Congress of Rehabilitation Medicine, New Orleans, Louisiana; November 16, 1978. |
| Woff, S.L.,
Basmajian, J.V.,
Russe, C.T.C. and
Kutner, M. | Normative Data on Low Back Mobility and Activity Levels: Implications for Neuromuscular Re-education. <i>Amer J Phys Med</i> , 1978. In print. |

Since this study places in clearer perspective the role of sympathetic blockade in the treatment of chronic low back pain, this information should assist clinicians in evaluating the efficacy of these blocks and the circumstances under which they might be used most effectively.

APPLICABILITY: Data have shown that each year seven million Americans are disabled by low back pain, with a consequent loss of 200 million man-days of work. Cases have been observed both at the University of Washington Pain Clinic in Seattle and the Emory University Pain Clinic in Atlanta where patients with chronic back pain have had as many as 10-15 back surgeries with no relief of pain, at an estimated cost to society around \$100.00 per patient. Data collected at the Emory University Pain Clinic suggest that sympathetic block therapy structured in an operant conditioning program for pain behavior control is of value in rehabilitating patients to function despite well documented conditions of chronic degenerative spine disease. The clinician confronted with problems of chronic back pain which have failed to respond to surgery has no other choice than to put the patient on analgesic and tranquilizing medication, ultimately leading to disability through drug habituation and abuse.

Information about the value of sympathetic block therapy as a technique for pain-control could facilitate functional rehabilitation of patients previously limited by pain and concomitantly reinstate those unfortunate individuals into productive and meaningful lives.

103 Training Improved Control of Spastic and Paretic Muscles with Computer-Controlled EMG Feedback

Principal Investigator:	Gary DeBacher, Ph.D.	
Status:	Continuing	
Dates:	August 1974-July 1979	
Cost:	Annual \$30,861 RT Annual \$25,909	Projected Total 210,781 RT % of Annual Total 80%
Annual Report Reference:	#14, Page 98, R-52	

OBJECTIVES:

1. To document in detail the EMG changes which occur during EMG feedback training to correct spasticity and paresis.
2. From such detail, to learn more about the nature of the learning process, especially the extent of generalization from trained to untrained muscles, the strategies patients use to inhibit spasticity, and generalization of control from one limb position to another.
3. To use this information to make decisions about how to improve application of EMG feedback in clinical settings.

METHODOLOGY: The project is based technologically on an on-line computer which controls training and data acquisition, and conceptually on a training task hierarchy. Subjects are first trained to relax spastic muscles in the resting state, if necessary. The more challenging tasks are introduced, including passive stretching of the muscle being trained, or voluntary contraction of its antagonist. EMG from up to four muscles is integrated every 1/10 second, digitized, and stored on disc memory for analysis. The computer generates auditory and visual EMG feedback displays and updates performance criteria based on the subject's progress in relaxation and control.

FINDINGS TO DATE: Ten subjects with spasticity and paresis have been trained on a variety of tasks. Eight received training to inhibit spasticity in elbow or wrist flexors during passive stretch at gradually increasing rates. Results for five were equivocal and not clearly indicative of learning. Three subjects learned to inhibit spasticity in the spastic elbow flexor from which feedback was derived, but showed incomplete generalization to the untrained spastic elbow flexors. This may imply that spastic synergists should be trained in groups rather than individually during clinical application of EMG feedback.

Three subjects were trained to better activate and control a paretic extensor muscle while inhibiting co-contraction of spastic antagonists. One succeeded remarkably and showed obvious improvements in extensor strength and muscle mass. A second subject's performance was improved on presentation of EMG feedback, but improvement in control of wrist flexors and extensors was minor, probably because of flaws in the training paradigm. Slow progress for the third subject, and lack of sensitivity to the presence or absence of feedback, suggest that observed improvements were primarily due to systematic practice.

APPLICABILITY: EMG feedback training is a new modality which is particularly useful with paretic and spastic muscles which are unresponsive to conventional neuromuscular re-education procedures. By itself, it is only a muscle training procedure, but training better control of individual muscles is sometimes an important pre-requisite to successful application of movement training procedures which produce functional gains.

104 Vasomotor Response Training in the Arthritic Patient

Principal Investigator: Gary DeBacher, Ph.D.
Status: Continuing
Dates: February 1976-February 1979
Cost: Annual \$11,806 Projected Total \$39,080
RT Annual \$11,806 RT % of Annual Total 100%
Annual Report Reference: #14, Page 108, R-58

OBJECTIVES: To determine the applicability and the effectiveness of peripheral blood flow training in reducing the severity of arthritis symptoms.

1. To measure the degree to which arthritic patients can learn conscious control of peripheral blood flow.
2. To measure the degree to which patients experience reduced arthritic symptoms.

METHODOLOGY:

1. The training technique was applied to 9 non-arthritic subjects to test the equipment and prototype.
2. Five pilot arthritic patients were trained and arthritis activity measurements taken over a six month period.
3. A controlled study is beginning in which half the patients will receive true feedback training and half will receive false training. Arthritis activity measurements will be taken over a six month period. The degree of symptom improvement will be compared between the two groups.
4. A study is planned in which small groups of arthritics are trained together without feedback in progressive general relaxation and peripheral vasodilatation. A waiting list control is employed. A variety of arthritis symptoms will be measured during and after training to see if improvements seen in pilot studies can be obtained with a group training method which might constitute an efficient, cost-effective therapeutic delivery approach.

FINDINGS TO DATE:

1. Five of the non-arthritic subjects received true feedback training and did learn to consciously produce changes in peripheral blood flow. Four received false training (as we plan to present to the control arthritic patients), and they did not exhibit the ability to control blood flow.
2. The five pilot arthritic patients all received true training.
 - a. Three exhibited good ability to control blood flow and were cooperative. Their arthritis symptoms generally improved over the six month observation period.
 - b. One patient probably had control over peripheral blood flow but was uncooperative and did not return for the six month re-check of blood flow control. There was mixed improvement of this patient's symptoms until the last measurement session during which it was observed that she had developed a reaction to her medication.
 - c. One patient did not exhibit the ability to control blood flow. She developed a reaction to her medication rather early in the study, and as a result, the medication was altered substantially. Her arthritis symptoms generally worsened over the period of observation.

We are encouraged by the results from the three patients who were cooperative and whose medication was constant or varied only slightly over the observation period. Results of these and related studies suggest that application of proper strategies and consistent practice may bring about learned relaxation and vasodilatation without use of expensive biofeedback technology.

APPLICABILITY: The daily activity of millions of arthritic patients is limited by the use of cumbersome treatment equipment and techniques (e.g., paraffin baths, heating pads, Hubbard tanks, and the use of massage). These techniques are difficult to apply outside of home or hospital. We are evaluating the effect on arthritis symptoms of a less restrictive therapeutic technique, the use of which would increase the patient's mobility, independence and employability.

105 Use of Feedback Goniometers to Increase Range of Motion in the Hand

Principal Investigator: Gary DeBacher, Ph.D.
Status: New
Dates: Not specified
Cost: Annual \$14,260 Projected Total \$27,000
RT Annual \$9,860 RT % of Annual Total GG
Annual Report Reference: #14, Page 43, R-61

OBJECTIVES:

1. To conduct studies to:
 - a. demonstrate the effectiveness of feedback goniometers for overcoming limitations in finger flexion/extension; and
 - b. learn more about how they may be optimally employed.
2. To make effective feedback finger and wrist goniometers generally available at a modest price.
3. To disseminate information about these devices and their use to the therapeutic community so as to induce a marked increase in their utilization.

METHODOLOGY:

1. Plans have been developed with which therapists can construct a simple but effective feedback finger goniometer from readily available tools and parts.
2. Experiments are underway to determine the effect of joint angle feedback on exercise behavior in normal volunteers and in selected patients undergoing hand rehabilitation. Additional comparison studies will be conducted to determine the extent to which therapy outcome is improved when feedback goniometers are integrated into a hand rehabilitation program.

FINDINGS TO DATE:

1. Clinical data obtained in the Emory Hand Management Center indicate that use of feedback finger goniometers produces somewhat more rapid and larger gains in active range-of-motion in patients recovering from tendon repair or from arthroplasty.
2. Experience to date with the "do-it-yourself" simplified feedback goniometers indicates that the average therapist can construct them successfully. They stand up well in clinic and home use, and they seem as effective for therapy as more complex electronic feedback goniometers.

APPLICABILITY: Systematic, progressive, active range-of motion exercise is part of the hand rehabilitation program for many patients after hand trauma or surgery. Joint angle feedback makes it possible for the therapist to closely control stress on healing tissues and gives patients concrete goals which foster motivation and compliance with exercise studies.

106 Expanding V.R. Services to the Cancer Disabled

Principal Investigator: Roger Decker, M.S.
Status: New
Dates: October 1977-September 1978
Cost: Annual \$59,400 Projected Total Not specified
RT Annual Not specified RT % of Annual Total Not specified
Annual Report Reference: #14, Page 260, Supplemental

OBJECTIVES: The purpose of this project was to establish a successful model system to serve the cancer disabled. It was originally intended to be a one-year project, but was extended to a second year to test the model system effectiveness. A secondary purpose of this project was to provide innovative counseling and rehabilitation services to cancer patients closely following the structure of

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Vocational Rehabilitation. The aim was to develop a system that would conform to state agencies' policies and procedures and be absorbed by the system at the termination of the project.

The objectives of the study were:

1. To develop and determine the effectiveness of a model system to serve the cancer disabled.
2. To increase the number of cancer disabled served by the state agency through the implementation of this model system in the current study.
3. To assist the cancer disabled to assume a more active role in developing a program for the cancer disabled by:
 - a. development of a survey to assess what information the cancer patient feels most necessary for him to know; and
 - b. distributing and analyzing program evaluation forms used to gather follow-up information.
4. To provide both traditional and non-traditional services to clients disabled by cancer during the second year of the project including services which would enhance the quality of life and the possibility of independent living.

METHODOLOGY: An outreach system was developed following a needs assessment which utilized information from cancer patients as well as professionals in the fields of medicine, allied health and rehabilitation. A systems approach was used to facilitate providing services and making referrals to appropriate agencies or groups when service by this project was not feasible. Two counselors were employed to establish liaisons with the medical community in the metropolitan Atlanta area and to provide social and counseling services to clients referred and accepted into the project. Financial, social, psychological, medical, and vocational services were provided. Rehabilitation success was determined by return to employment/school/household activities and personal/social interaction as demonstrated by establishment of goals.

FINDINGS TO DATE: While this project was not restricted to goals which were vocational in nature, the primary concern of the staff of the project was to demonstrate the employability of the cancer disabled. During the two years of the project 108 subjects were referred for services from 7 sources. Vocational goals were established for 52 clients. A variety of services were rendered including: financial assistance, training, counseling, psychological support, vocational evaluation, and job placement assistance. A total of \$27,000.00 in case service funds was expended on 28 clients. Many similar benefit programs were discovered that provided financial support and reduced the cost to VR. To date 1 client has been trained, indicating that many of these clients do not need extensive training, but can transfer work skills to similar occupational areas. Job placements have numbered 21. Data supports the contention that the cancer disabled individual is employable if contacted early in the diagnostic/treatment process and counseled regarding retention of employment when possible, retaining vocational goals through the treatment process, or acquiring new goals compatible with any functional loss. As with any disability, referral after a long period of unemployment, more extensive behavioral and attitudinal changes are required.

APPLICABILITY: Traditionally, one of the most avoided caseloads in vocational rehabilitation is that of the cancer disabled. This project established a workable model to serve this population and demonstrated their employability. The model can be adapted effectively in any location with resources similar or dissimilar to those in the Atlanta metropolitan area.

107 Renal Rehabilitation Success Determination

Principal Investigator:	S.B. Chyatte, M.D.	
Status:	Transferred	
Dates:	Not specified	
Cost:	Annual \$154,000 RT Annual \$54,000	Projected Total \$54,000 (RT funds) RT % of Annual Total 36%
Annual Report Reference:	#14, Page 255, Supplemental	

OBJECTIVES:

1. To assess, in a uniform numerical fashion, the status of ESRD patients on hemodialysis from:
 - a. a medical aspect;
 - b. a rehabilitation aspect;
 - c. the patient's own perspective.
2. To determine if the patient's perspective of his "success" correlates with the examiner's perspective of "success."
3. To define barriers to all three forms of "success."
4. To advise and institute remedial programs for identified barriers.
5. To ultimately facilitate employment for appropriate patients.
6. To develop a questionnaire which will be usable on a national level to define barriers to "success."
7. To develop and institute a model for a national remedial program.
8. To develop and institute a national employment program through state vocational rehabilitation agencies.

METHODOLOGY:

1. Patient Selection

- a. Patients will be selected from those with End Stage Renal Disease on hemodialysis living in the metropolitan Atlanta area.
- b. Patients will range from age 16 to 60 years, with no regard to sex or race.
- c. Patients may be victims of more than one disorder (e.g., diabetes, mellitus, hypertension, neurological disorders, etc.).
- d. The bulk of the patient population will have been on hemodialysis for three months or more.
- e. Patients may be employed, unemployed, homemakers, or students and may be motivated or not toward outside or gainful employment.
- f. By agreement with the Division of Vocational Rehabilitation of the Department of Human Resources of the State of Georgia, the first 25 patients will be clients of Vocational Rehabilitation and preferably patients from Dialysis Center Inc. This agreement was made to serve the patient population with the greatest need first.
- g. The subject number is open-ended with a minimal goal of 50 patients by the end of the first 12 months.

2. Data Collection and Analysis

a. Data Collection

- (1) Patients will be assessed at baseline and at three months.
- (2) Data will be obtained in part from the referring patient, in part from the examiners and in part from the patient's own assessments.
- (3) The physicians will be assisted by other health professionals in collecting the data.

b. Data to be Collected

- (1) Medical History Sheet
- (2) Medical Success Data Sheet
- (3) Medical Success Rating Sheet
- (4) Intake Question Guide
- (5) Fatigue and Sleep Rating
- (6) Activity List
- (7) Rehabilitation Success Data Sheet
- (8) Rehabilitation Success Rating Sheet

- (9) Physical Examination Sheet
- (10) Activities of Daily Living Evaluation Sheet
- (11) Hester Evaluation - Description of each test chosen (from Hester Manual)
- (12) Hester Evaluation Rating Sheet
- (13) Patient Success Questionnaire
- (14) Patient Success Rating Sheet

c. Data Processing

- (1) All values will be on a numerical basis and can be coded (e.g., II 5_b will refer to Medical Success data sheet item 5_b which is BUN) for ease in handling).
- (2) Comparisons to be made:
 - A. Medical success vs. rehabilitation success
 - B. Medical success vs. patient success
 - C. Rehabilitation success vs. patient success
 - D. Factor analysis of what contributes to each index of success
 - E. Factor analysis of what contributes to overall success

d. Statistical process to be used:

Correlation Analysis: Pearson product - moment correlation co-efficient or Spearman rank correlations. Following this, a discriminate analysis may be employed.

e. Manner in which data will be processed: Data will be coded and computerized.

FINDINGS TO DATE: Forty-three patients with End-Stage Renal Disease were evaluated to determine medical success, and patient assessment of satisfaction following hemodialysis of 3 to 119 months. The system developed during this one-year study represents an attempt to implement a numerically based global approach which will serve as a guideline to determine the rehabilitation characteristics and needs of the renal disease population.

From this one-year study has evolved a three-year longitudinal study titled, "Medical, Psychosocial, and Vocational Evaluation of Kidney Transplant and Dialysis Patients," currently in progress.

Several articles have been published as an outgrowth of this study:

- 1. Roth, M., Chyatte, S.B., Parker, D., Stegall, P. **End-Stage Renal Disease Success Determination: The Evaluation Method**, Dialysis and Transplantation, Volume 7, Number 6, June 1978.
- 2. Stegall, P., Chyatte, S.B., Roth, M., Parker, D. **Cognitive Motor Evaluation of the ESRD Patient**, Dialysis and Transplantation, Volume 7, Number 6, June 1978.
- 3. Chyatte, S.B., Roth, M., Parker, D., Stegall, P. **End-Stage Renal Disease Success Determination: First Year Results**, Dialysis and Transplantation, Volume 7, Number 6, June 1978.

APPLICABILITY: Not specified.

108 Video-Tape Assisted Patient Education

Principal Investigator:	J.R. deAndrade, M.D.	
Status:	Transferred	
Dates:	January 1978-December 1979	
Cost:	Annual \$28,000 RT Annual Not specified	Projected Total Not specified RT % of Annual Total Not specified
Annual Report Reference:	#14, Page 265, Supplemental	

SUMMARY: This proposed project was supported only as a one year supplement; therefore, the work on this project was primarily exploratory. The purpose of the proposed project was to develop and test prototypes in video-tape format for patient family education and self-instruction in several disability categories. With the limited monies available, the intent was severely compromised. The

results of the effort that was possible nevertheless further reinforces the need to pursue the original intent as monies for staffing become available.

Several test tapes were developed. The new project R-65, Clinical Effectiveness of Patient Self-Instruction in Physical Rehabilitation Skills and Implications for Delivery Systems is partially an outgrowth of the exploratory work done through this grant.

109 Quantitative Assessment of Postural Stability and Steadiness in Stroke Patients and Control Subjects

Principal Investigator:	Bernard A. Cohen, Ph.D.	
Status:	Deferred Principal investigator moved to another position elsewhere and the study has not been reactivated to date.	
Dates:	February 1976-February 1980	
Cost:	Annual \$22,900 RT Annual \$22,900	Projected Total \$85,000 RT % of Annual Total 100%
Annual Report Reference:	#14, Page 24, R-59	

OBJECTIVES: The first objective is to refine a technique for the quantitative assessment of postural steadiness and stability. This will be done using normal subjects to establish normative data for various age groups (Seldon, 1963). The second objective is to obtain these same force platform measurements on stroke patients beginning as soon after their hospitalization as possible and continuing through the hospital rehabilitation period at weekly intervals. Changes in these measurements will be correlated with results from clinical diagnostic tests (EEG, angiography, brain scanning, etc.) to evaluate the efficacy of various medical therapeutic procedures. The third objective is to quantify the patient's rehabilitation therapy progress utilizing methods similar to those expounded by Simons (1970) and relate the changes found with those quantified measures mentioned above. The fourth and final objective is to utilize the accuracy and sensitivity inherent in a research tool (i.e., the force platform) to evolve a new as well as less expensive and more portable clinical equivalent tool or technique which will enable widespread utilization of the results from this study.

METHODOLOGY: A force platform is being used to measure the magnitude of the total vertical supportive force and the excursion of the center of pressure of this force in the fore-aft and medio-lateral directions. The movement of the center of pressure varies according to the movement of the center of gravity and the distribution of muscle forces required to control or produce movement.

Control subjects are selected from among volunteers. They are screened to present physical characteristics closely allied to that of the stroke patient population except for the required absence of any known neurologic deficits or gait anomaly. Patients suffering from stroke, ataxia or other cerebrovascular or neuromuscular gait disorder are provided for recording by the Emory University Medical School Hospital and its allied health care institutions. Recordings are made in the Kinesiology Laboratories of the Emory University Center for Rehabilitation Medicine.

Subjects are asked to stand on the force platform without the aid of additional support if at all possible. Each subject is asked to stand with feet apart in a comfortable position and then shifts his/her weight first forward and backward and then in the left and right directions, and sustain the inclined postures for a period of time. Patients unable to stand by themselves will be tested using various assist devices (e.g., crutch, cane, or bench). Testing of patients sitting on a backless chair enables evaluation of severely acute stroke subjects who are not yet able to stand on their own. Using a polygraph, continuous recordings are obtained of the excursion of the center of pressure. The center of pressure records are transposed to an x-y plot depicting the shifting in center of pressure during standing and weight shifting activities.

FINDINGS TO DATE: In the first study, effects of wearing shoes and not wearing shoes were assessed with 25 control subjects. Relatively little difference in the postural stability and steadiness of subjects

with or without shoes was observed. Most of these observations were based on a comparison between barefoot stance in normal low, flat street shoes.

Evaluations were also conducted to determine the optimum stance required for uniform data. Normal subjects were asked to run through a series of foot stance tests consisting of normal upright standing posture with each test having the feet spaced progressively wider. For uniformity, the measurement of foot spacing was obtained between a medial malleoli of the subject. An inspection of the data showed that a spacing ranging between 2 and 25 centimeters resulted in approximately the same stability. Therefore, in subsequent sub-studies subjects were tested with a uniform foot separation of 13 centimeters between medial malleoli.

The effects of supplying the subject with feedback versus no feedback on the amount of motion on the center of pressure were also assessed. For this sub-study, 40 normal subjects participated.

The feedback element in the present study consisted of the generation of a signal on the video display corresponding to the motion of the center of pressure of applied force on the platform. Therefore, if the center of pressure of applied force on the platform shifted left by 5 centimeters, an analogous displacement of 5 centimeters was noted on the visual feedback display. Throughout the entire evaluation, the subject was requested to fixate on this point. During the nonfeedback evaluation the subject fixated on the point centered motionless on the screen.

As can be expected, feedback conditions greatly influenced the results of this sub-study. External feedback in the form of a projected dot on a television screen decreased the effort needed by an individual in maintaining postural stability. Both X and Y reaction forces were lower for testing with feedback conditions; the same situation was apparent when reaction moments were considered.

When considering the total distance traversed by the center of pressure during each test period other factors evidently need to be considered. When feedback was employed, the test subject relaxed and stood on the platform under a test condition that was similar to real life (i.e., one looked at one's environment and processed information to help maintain stability); subjects appeared to do this unconsciously. As the test progressed one fixes on a spot where all of the feedback information is presented and thus must consciously process relatively little data for stability. Then as a result of sway, increases in the effort needed to control stability are minimal. The last test condition was a return to the normal situation and we postulated that the individual may be "cheating" somewhat, using other inputs instead of those required by the test.

When testing for sway without feedback we postulated that the individual was relying on an interfeedback loop that does not allow elaborate freedom of motion (hence it decreased sway) and must increase the internal effort to do so, hence increased movements and forces.

With the information derived from the two sub-studies a larger control population was assessed to establish the normative data base. Little variation was seen in the data for any of the upright sequences; that is whether the subject has leaned in any direction before an upright phase, the normal individual exerts the same effort to maintain his posture. Emphasis has frequently been placed on the fact that standing posture is a dynamic event and that small amounts of postural sway are to be expected regardless of the age of the patient. This observation is supported by the results generated in this study.

During upright posture, forces of 0.68 and 3.81 newtons in the xz (medial/lateral) plane and the yz (anterior/posterior) plane, respectively, are required in normal subjects to maintain stability. That sway, as measured by the motion of the subject's center of pressure traverses a distance of approximately 3.3 centimeters on the platform surface. The motion is ellipsoidal in shape with maximal deviations along the long (y) axis. At the present time we do not know what the direction of ellipsoidal motion is (i.e., clockwise or counter clockwise), nor whether this direction is controlled by right or left side dominance.

In reviewing the data presented, we find that both forces and center pressure location in the medial/lateral plane are smaller than the corresponding values for the anterior/posterior plane. Apparently, the body can subconsciously correct for side to side sway with less difficulty than front to back and, therefore, in normal subjects this sway (side to side) is very closely controlled. Normal subjects appear to correct front to back motion more drastically than by increasing the relative effort in maintaining stability.

APPLICABILITY: Intelligent use of services available to the hemiplegic calls for quantification of many of the diagnostic and therapeutic procedures currently being utilized. This research is intended to provide a new quantification technique for evaluation of neuromuscular function, and correlation of these findings with other clinical diagnostic tests and with specific courses of therapy.

The data gathered to date can be used in several ways. Patients may be screened for possibility stability related diseases such as ataxia or labyrinth dysfunction. Second, data from this project should also be useful in evaluating the recovery of patients who have had a stroke which may affect their stability. This aspect of the project is being continued by the principal investigator although he has moved to another institution. Third, the data may further prove beneficial in evaluating the results of hip replacement procedures and the effects of various external lower limb prosthetics used by amputees.

110 Hormonal Agents in Myopathy ... Metabolic Studies in Muscular Dystrophy

Principal Investigator:	Daniel Rudman, M.D.	
Status:	Discontinued	
Dates:	This project has been underway since 1971 and will continue for several years hence.	
Cost:	Annual \$5,600 RT Annual 600	Projected Total \$5,000 RT % of Annual Total 5%
Annual Report Reference:	#14, Page 17, R-14 & R-15	

OBJECTIVE: To develop a method to detect the premyopathic stage of myotonic muscular dystrophy.

METHODOLOGY: The metabolic balance study technique was used to quantify responsiveness to the anabolic action of human growth hormone.

FINDINGS TO DATE: A previous study showed 4 men with myotonic muscular dystrophy (MMD) retained 3 to 10 times more N, P, K, Na and Cl than normal men in responses to 0.168 unit human growth hormone (HGH)/kg (body weight) 3/4/day. The present investigation aimed to learn if the trait of hyperresponsiveness to GH could be used to determine the premyopathic state of the disease. Subjects were 3 MMD parents and 16 of their offspring ("B" and "W" kindreds). Each individual was evaluated for clinical muscle disease (atrophy, weakness, myotonia), 3 conventional premyopathic indicators of MMD (cataract, depressed immunoglobulin G, myotonic discharges in the electromyogram), and hyperresponsiveness to HGH. Among the B and W offspring, 3 had "clinical muscle disease" (atrophy, weakness, myotonia), 4 had no clinical muscle disease but exhibited one or more of the indicators of premyopathic MMD, and 9 had neither clinical nor premyopathic abnormality. To investigate a sex difference in hyperresponsiveness to HGH which became apparent in the B and W families, the study was extended to include 11 adults with clinical MMD from other families.

Hyperresponsiveness to HGH was exhibited by all 9 males (age 19-52) with clinical MMD, and by all 3 male B and W offspring (age 28-34) who did not have clinical disease but who did show presence of a premyopathic indicator. In addition, of 8 male offspring without clinical or premyopathic abnormality, 5 (age 18-24) were hyperresponsive to the hormone. Three post-menopausal females with clinical disease were hyperresponsive. Contrastingly, four females with clinical MMD and one with the premyopathic stage, all of whom had normal menstrual function, were unresponsive to HGH.

In 7 males with clinical MMD, all of whom were hyperresponsive to HGH, the administration of 4 ug ethinyl estradiol/kg (body weight) 3/4/day simultaneously with HGH suppressed the anabolic reaction to the latter hormone.

These observations indicate that in the male carrying the MMD gene, hyperresponsiveness to HGH develops by age 18 and precedes the appearance of cataracts, depressed immunoglobulins, electromyographic myotonic discharges, or clinical atrophy and weakness. In the myopathic or premyopathic MMD female with normal menstrual function, hyperresponsiveness to HGH is not present, but after the menopause this characteristic becomes detectable. The sex difference

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probably results from inhibition of the anabolic response to exogenous HGH by endogenous estradiol in the female heterozygote with normal ovarian function.

A new approach has been developed based on the finding that MMD patients are hyper-responsive to the metabolic effects of exogenous human growth hormone. We have found that in male MMD genetic heterozygotes, the characteristic precedes the appearance of clinical myopathy by a decade or more. Hyperresponsiveness to growth hormone is the most sensitive method so far described for detecting preclinical MMD in the male (D. Rudman, M.D.). The project will continue under its other auspices.

APPLICABILITY: Myotonic dystrophy is a disease which reduces the functional capacities of the patient. Early detection of the premyopathic or carrier state can facilitate rehabilitation planning and genetic counseling. The findings will be used in continuing investigation into the causes of muscular dystrophy. RTC support of this project which has been minimal (2% each year) is being withdrawn by mutual agreement, because of the death of Dr. Chyatte.



**Tufts University (RT-7)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Biomedical Engineering

Using modern technology to develop products for environmental modification and improved communication for persons with severe physical disabilities.

Consumer Involvement

Research into the state-of-the-art and development of models for meaningful participation in the rehabilitation process by persons with disabilities.

Universe of Need/Patient Care

Activities which have resulted in the development of a computerized functional assessment and outcome evaluation system for medical rehabilitation facilities.

TUFTS UNIVERSITY

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Boston, Massachusetts 02111

COMPLETED

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111 Research in Upper and Lower Extremity Orthotics

Principal Investigator: James O'Leary, M.S.
Status: Completed
Dates: January 1971-October 1978
Cost: Annual \$21,977 Projected Total \$170,752
RT Annual \$14,529 RT % of Annual Total 65%
Annual Report Reference: #13, Page 131, B-24

OBJECTIVE: To investigate methods of manufacture which will make light weight orthotics more readily available.

METHODOLOGY: Experience in experimentally fabricating orthoses indicates that the process of forming from plastic sheets is relatively easy to master as a task. It does, however, require a significant investment in training time to master these skills.

Improvements are being sought in fabrication methods and design of these devices which will reduce the initial cost of gaining lightweight orthotics capability. The vacuum forming process reduces the learning effort required, but commercially available equipment for this process is expensive. Development of an inexpensive vacuum forming system to be used in an orthotist's work area has been a primary step in this project.

A system which meets these needs was designed earlier in this project and is currently in use in nine locations. This usage is being evaluated for possible problems or areas where improvement could be obtained.

Further effort is required in the area of orthotic design that utilizes the properties of polypropylene. The use of the vacuum forming system in the fabrication of orthoses other than the ankle-foot device is presently being investigated.

FINDINGS TO DATE: The project has concentrated on the effort to develop more effective utilization of vacuum forming systems through the inclusion of other orthotic and orthopedic devices as possible products from such a system. Work has progressed on the plastic knee brace, as well as a variety of long leg orthoses.

Design of the existing vacuum forming system has been stabilized and described in various publications. Units built by the BMEC have been provided to Mass Rehabilitation Hospital, The Veterans Administration, and RT-3 at the University of Washington at Seattle. A fourth unit has been provided to the University of Washington for use in their project in South America. Certain design changes may result from reports from these locations.

The design of a large sized vacuum forming table which can accept molds the size of wheelchair parts has been completed. Technology similar to the smaller table was used in order to make this a cost effective device. Construction was accomplished during the summer of 1977.

Custom fitted polypropylene foot-ankle orthosis has a problem regarding an increased occurrence of breakage. The failure has predominantly been in the ankle area and has been brittle in nature. For this reason, tests were conducted to determine the causes of these failures. Three different sample groups were tested. These include: (1) samples exposed to sunlight for long periods, (2) samples heated and rapidly cooled, as in the brace forming process, and (3) samples to determine the edge effects, rough edges vs. fire polished.

Each of these groups were put through a battery of tests which include a low speed tension test, high speed tension test, and a dynamic tension and compression cycle at various speeds. The dynamic test was done in two modes: the first was a force limited test, and the second was a deflection limited test.

From the tests, it was recommended that the cooling rate of the plastic in the forming process be increased substantially from the present rate. This will allow finer crystallization of the plastic and increased fatigue and impact resistance. It is also recommended that the brace be trimmed back in the ankle area, to allow for more flexing when it is possible to do so.

A final report covering the full span of this project was completed in late 1978.

APPLICABILITY: It is expected that this work will result in wider availability of lightweight orthotic devices.

112 Follow-Along Study of a Medically Disabled Population in Fall River, Massachusetts: A Controlled Trial of Surveillance as a Means to Support Functional Independence

Principal Investigator: Carl V. Granger, M.D.
Status: Completed
Dates: November 1973-September 1978
Cost: Annual \$42,218 Projected Total \$168,880
RT Annual \$31,213 RT % of Annual Total 74%
Annual Report Reference: #13, Page 18, 2-35

OBJECTIVES:

1. To determine if follow-along of patients discharged from a hospital rehabilitation unit who are under the surveillance of case aides can reduce the number and severity of acute medical care incidents or hospitalizations and/or chronic institutionalizations.
2. to test whether periodic objective and comprehensive assessment of functional capacity in these patients provides a practical measurement of outcome and/or provides a useful indicator of sustained capacity and maintenance care needs of rehabilitation patients.

METHODOLOGY:

1. The study group will consist of patients discharged from rehabilitation treatment and evaluation programs in the greater Fall River area during the 18-month period following the beginning of the study. The study group will be stratified on the basis of a five category diagnostic procedure. Each member of the study group upon discharge from the rehabilitation treatment program will be randomly allocated to one of three groups of about 75 patients.
2. Group I will be kept in contact by case aides who will note any change in functional capacity subsequent to discharge. Changes will be evaluated by a professional rehabilitation team which, in addition, will evaluate the group upon admission to and discharge from the rehabilitation program and at 6 and 12 months after discharge. Appropriate rehabilitation steps will be taken on the basis of those evaluations.
3. All members of groups 2 and 3 will be evaluated by a professional rehabilitation team upon admission to and discharge from the rehabilitation program, at 6 months after discharge (for group 2 only) and at 12 months after discharge. Appropriate rehabilitation steps will be taken on the basis of each evaluation.
4. Measurements of the functional life status and quality of life status will be taken of each member of all three groups on admission, discharge, and one year after discharge. Outcome measures pertaining to hospitalization, institutionalization, medical status, and medical care services will also be obtained for all members of the three groups for the one year period following discharge. The Programmed Summary of Functional Status (PSFS) and a Quality of Life Measures will be used.

FINDINGS TO DATE: A joint program in rehabilitation research has been established between the Tufts Rehabilitation Institute and the Hussey Hospital in Fall River. The PSFS has been applied on 150 patients in the Fall River area with satisfactory results. A social interview was developed to include quality of life measures previously developed and utilized in a number of other research studies. Arrangements were made with the Home Health Agency of Fall River for the services of the case aides who will provide the follow-along intervention surveillance.

A total sample has been developed of 142 persons: 41 in Group I, 49 in Group II and 52 in Group III. The mean age is 58.9. After attrition due to death, moving away or loss to follow up by refusal, 114 persons completed the post-test interviews. Analytic techniques were used to test change in functional status between pre-test and post-test and to determine the impact of the medical monitoring and friendly visitor intervention.

A final report, summarizing the findings, was completed in late 1978.

APPLICABILITY: There is a great need for the development of a program to evaluate the follow-along approach to the care of chronic rehabilitation patients as well as more efficient medical care delivery with fiscal containment. This program is concerned with both areas as well as the development of more specific information on the functional assessment of patients.

113 Computer Aided Motor Communication for the Severely Disabled Non-Vocal

Principal Investigator: Richard A. Foulds, M.S.
Status: Completed
Dates: November 1973-October 1978
Cost: Annual \$15,480 Projected Total \$152,780
RT Annual \$15,117 RT % of Annual Total 97%
Annual Report Reference: #13, Page 142, R-44

OBJECTIVES: The research will be directed towards maximizing the motor communication rate of the severely disabled non-vocal person through the use of a high speed digital computer. Several noncomputerized communicators have been developed in recent years which interpret "yes" - "no" commands and allow the motivated client to communicate at a rate of up to 12 words per minute. This is well below the speed of an average typist (approximately 55 words per minute) and far below the rate of human speech which can exceed 200 words per minute. The relatively slow rate of those communicators can result in extreme frustration on the part of a user with normal intelligence.

METHODOLOGY:

1. Develop a computer software package which will anticipate the redundant information in a message and thereby increase the motor communication rate. The computer software package will reside in a large general purpose digital computer (most likely the DEC System 10 at Tufts University) and will be accessed over the telephone lines. Program evaluation will be performed on a cathode ray tube (CRT) display terminal.
2. Do exploratory studies on normal individuals interacting with the "intelligent" communicator to establish its utility. A baseline for motor communication rates will also be established at this time.
3. Once the programmable communicator is functional, it will be introduced into the special education classroom for use. Progress of the students in their reading and writing abilities will be assessed both before and after the introduction of "intelligent" communicator to indicate their progress. Based upon the exploratory studies, a prototype communicator will be developed which will be integrated into a clinical setting. Tests will be performed to determine the increase in communication output rate (if any) and to identify difficulties in the man-machine interface. These difficulties will become the focus of future design efforts.

FINDINGS TO DATE: The concept of anticipatory scanning based upon statistical information has offered ideal typing improvement since the early analysis of the data. The engineering effort has been aimed toward developing the appropriate human-machine interface and the hardware development necessary to put a device into a clinical testing situation.

The major accomplishment of this past year has been to refine the concept of a dynamically scanned keyboard that was introduced in the RT-7 Annual Report for 1975-76.

This system not only reduces the amount of time required to output a message, but also reduces the amount of physical effort required to make that output.

Each of the two dynamic characters required only a single switch signal. Since they potentially represent 75-80% of the choices, there will be a reduction of 35-40% of physical effort. The typing rate is improved by nearly 40% depending upon the message.

The utilization program explained in project R-25 will include an anticipatory scanning feature as part of the Tufts Interactive Communicator.

APPLICABILITY: The development of an "intelligent" communicator which can increase the motor communication rate of a severely disabled non-vocal individual should have a profound effect on all his social encounters. Among other things, it may allow a more valid assessment of the intelligence of such an individual by bypassing his motor disability.

The importance of effective communication in rehabilitation cannot be overstressed. The need for a means of expressing desires and feelings is one that must be satisfied in all people regardless of their disability. The importance of this project is that it will allow a person to perform at the highest level of his ability. As described in the introduction to the Biomedical Engineering core-area of

research, this project is consistent with RSA research objectives in Research and Evaluation Area "N", Rehabilitation Engineering.

114 Effect of Home Modification on the Functional Performance on the Physically Handicapped

Principal Investigator: Jonathan C. Bretz, B.S., O.T.R.
Status: Completed
Dates: July 1976-October 1978
Cost: Annual \$49,465 Projected Total \$93,883
RT Annual \$44,549** RT % of Annual Total 90%

**Includes 1976-1977 Supplemental money in 1977-1978 budget.

Annual Report Reference: #13, Page 165, R-59

OBJECTIVES

1. To determine the extent to which structural modifications of private dwellings (homes, apartments) improve or heighten the functional performance of physically handicapped persons living therein.
2. To apply measurement instruments of functional assessment to persons with disabilities in inaccessible and accessible home structure before and after architectural modifications.
3. To present data on the benefits and costs of the Rehabilitation Adaptation Service project to health insurance companies and other fiscal third-party agencies (e.g. Medicaid, Medicare) and to encourage them to add Rehabilitation Adaptation Services coverage to their policies.
4. To facilitate future investigation of the relationship between functional performance in the homes of physically handicapped individuals and home modification.

METHODOLOGY: For purposes of this research project, candidates for home modifications were screened on three criteria:

1. ability to perform activities of daily living is limited due to a physical disability (i.e., persons who are paralyzed, required ambulation aids, have neurological diseases, etc.);
2. live within a forty mile radius of T-NEMC;
3. are willing to have functional assessment evaluations administered before and after modifications are made (for purpose of this research project, requirements were more stringent than standards that might be developed by independent or state agencies.)

Early in the project, a brochure was designed and sent to professionals with clients who might meet the requirements. Referrals could be made to the project coordinator by telephone for consideration as a study participant.

The modifications undertaken by this study were limited to \$500.00 per client, partly due to budget constraints, but mainly to extend the revenue to as many people as possible. To date, the most impressive outcome of this project has been the number of low-cost modifications: at the end of the first project year (October 30, 1977), the average cost per client (total 23 clients) was \$397.93. This includes ramps, bathroom and kitchen modifications, threshold removal, and door widening.

Once referred, the next step involved a carpenter and an O.T.R. to determine, by home assessment, exactly what was needed by the individual. Again, if the estimate was within the \$500.00 limit, the modification was applicable to this study.

Before the modification was started, an adapted version (developed especially for this study) of the Granger Long Range Functional Assessment (RT-7 Annual Report, 1975) form was administered to determine the present functional level of the individual. Once the work was completed and an appropriate time was allowed for the person to become accustomed to the change (i.e., 6 weeks), the same form was administered again. Any changes in functional independence would show in the analysis of these forms. Further statistics will be obtained through comparison of study forms to those of non-study forms.

FINDINGS TO DATE: All study participants have been identified and required modifications have been or are being completed.

Through the course of the project 83 referrals were made. Of these 83 persons, 42 were selected as study participants, ranging in age from nine (9) years of age to eighty-eight (88).

Home assessments have been completed on all participants. Pre and post-functional assessments have been administered to 23 of the total 42. Pre-tests have been given to all but 3 subjects, which will be completed in the next month. Post-tests will be completed as the jobs are finished, with expected completion of the jobs and post-functional assessments in September, 1978.

The average cost per client has risen to approximately \$500.00, but is still fairly cost effective. This is due to more ramps being built.

Initial analysis of the data collected in the functional assessments has begun. The data from seven (7) participants has been analyzed with the following results:

Pre-test results placed 10% of the 7 participants in the moderately handicapped category; 60% were classified severely handicapped and 30% profoundly handicapped.

Post-test results placed 40% of the participants in the moderately handicapped category, 40% severely handicapped and 20% profoundly handicapped.

Analysis of the data continued until October of 1978.

APPLICABILITY: The investigator recognizes that home adaptation is an important need for the physically handicapped person to live independently. As rehabilitation personnel work with the handicapped, they focus on two major aspects. The first is the restoration of function through encouraging the residual abilities of the patient. The second is the adaptation of the patient's environment. The first focus is usually the concern of the rehabilitation team, consisting of the physician, rehabilitation nurse, physical and occupational therapists. The occupational therapist of this team has been traditionally expected to zero in on the adaptations for physically handicapped individuals. Through the use of self-help devices, equipment, etc., an attempt toward independent living is built into the treatment planning. The occupational therapist, therefore, manipulates the environment while teaching the restoration of function. Hence, their involvement with home modifications.

Once the client is sent home, however, many cases occur where those rehabilitation skills attained by this patient in the hospital are impossible to execute due to the need of structural changes in his home. The disabled person confined to a wheelchair views the environment from a different perspective than the able-bodied person. First of all, his height is cut down to the height of the chair. Secondly, his width is added to through the dimension of the chair. Thirdly, this person has difficulty getting through doorways, up to closets, cabinets, under tables, kitchen sinks, using bathroom facilities or getting basic household tasks completed.

The deficiency in proper home structure and adaptation have made it quite difficult if not impossible for some discharged physically handicapped persons to live independently. The medical rehabilitation team may not be able to complete their job of assuring maximum independence of their patient when these home adaptations are not available. Some of the handicapped elderly, for instance, have no other choice but to enter a nursing home. Some of the young disabled go to chronic care facilities -- **an unnecessary waste of human resources.**

Successful vocational rehabilitation is more likely if the person with severe physical disability is able to function independently in his home environment. In particular, if a person cannot get in and out of his home, it is difficult to get to and from work. A major portion of these problems may be remedied by the teamwork of a carpenter and the occupational therapist.

With current pressures on the various third part coverage organizations to cut costs and prevent institutionalization, this service becomes more significant from a cost-effectiveness angle. A number of cases have come to our attention where recovery was delayed, accidents happened, hospital stays were prolonged, needless costs were incurred for the services of homemakers and home health aides, or patients went to nursing homes or chronic care facilities, all for the lack of a Rehabilitation Adaptation Specialist.

A major question in both Area A, Universe of Needs, and Area B, Selection and Counseling Process, Areas of the RSA FY 1977 R&E Strategy, relates to functional assessments and other measures used in the Comprehensive Needs Study as well as measures that examine the extent to which the environment is severely handicapping.

The project also ties into Area N, Rehabilitation Engineering. A research objective there is to

develop methods of eliminating architectural barriers which hinder the mobility and employment of persons with severe disabilities.

115 Feasibility Study of a Management Training Program for Severely Physically Disabled Persons

Principal Investigator: Bruce E. Marquis, M.A.
Status: Completed
Dates: July 1976-June 1978
Cost: Annual \$34,336 Projected Total \$58,505
RT Annual \$33,319 RT % of Annual Total 97%
Annual Report Reference: #13, Page 302, R-60

OBJECTIVES

1. Document a detailed curriculum for this on-the-job training program for potential managers.
2. Establish linkages with management schools in the Greater Boston area in terms of their support for the involvement of persons with severe physical disabilities in academic programs in business administration and management.
3. Maintain appropriate supervision of four trainees at primary job sites.
4. Provide a plan of supervision of the trainees in order to assure consistency in expectations toward their performance.
5. Evaluate the progress of the trainees, as well as the appropriateness of the curriculum and the quality of the training settings.
6. Develop career opportunities for the trainees and other severely physically disabled persons in private and public social service agencies and industry.
7. Demonstrate the feasibility of such an on-the-job training program.
8. Document the results of the program after two years and disseminate the data to other pertinent persons and organizations for review and comment.

METHODOLOGY

1. The curriculum was further developed for use by the trainees, linkages with schools of management were maintained, and the recruitment of trainees was continued.
2. Regular meetings of the trainees and primary personnel were provided to insure proper supervision of the trainees and support for the implementation of the program plan.
3. Evaluation tools in the form of written examinations were utilized; in-depth interviews and observation of on-the-job performance also was used.
4. The research committee worked with industry and social service agencies to develop career opportunities for the trainees.
5. Consumers were involved in all aspects of the planning, implementation, and evaluation of the program.
6. A faculty of able administrators and resource persons continued to instruct mini-courses (6 hours of volunteer time) in the following skill-development areas:

Board & Committee Work
Community Organization
Consumer Involvement
Educational Methods
Facility Management
Fiscal Management
Fund Raising
Government Relations
Interpersonal Relations
Leadership

Legal Issues
Objective Setting
Planning
Problem Solving
Program Development
Public Relations
Relations with Professional Community
Research and Evaluation
Vocational Rehabilitation
Volunteer Development

The mini-courses were open to auditors, who are persons with severe physical disabilities, employ-

ed in other settings, and who chose to participate in the mini-courses only.

7. Specialized management training skill development was provided through intensive three-day sessions utilizing American Management Association course materials. Through audiovisuals, guide books, lectures and discussions, information on principles of management and leadership were provided. A grantsmanship course (2½ days long) provided several trainees with intensive skills, useful in present and potential positions.

FINDINGS TO DATE: The feasibility of recruiting and placing trainees is proven. Specialized training modules such as the American Management Association sessions and the mini-courses have been successful and worthwhile. Important linkages have been established with industry, CETA programs, schools of management, the Massachusetts Rehabilitation Commission and key consumer organizations.

However, the focus of the program changed from the original concept of developing managers, to placing entry-level persons in service-related positions, although they may be aspiring and developing toward management-related positions. Therefore, the Management Training Program has proven to primarily be a placement program, which also provided the trainees with a fair amount of exposure to principles of management and role models after whom to pattern themselves. These role models were provided by the lecturers of the mini-courses as well as the supervisors of the trainees.

Problems that have been encountered included:

1. Economic disincentives for the trainees.
2. Slow response from the division of vocational rehabilitation.
3. Difficulty in acquiring training sites.
4. Lack of flexibility in the CETA program.
5. Difficulty in the coordination of trainee schedules to allow for group meetings and other joint activities.

APPLICABILITY: Information from this project is most useful for rehabilitation professionals working with severely physically disabled persons in employment placement and on the job. Disabled persons will find the study informative and useful as they relate the experiences of job trainees to themselves. Persons working on issues of the Rehabilitation Act, Section 503 and 504 should find the information useful. Federal and state rehabilitation services administrators will also gain insight into gaps in service areas and needs of severely physically disabled persons. Rehabilitation agencies should find it helpful in practicing "affirmative action" themselves.

116 Consumer Involvement in Rehabilitation

Principal Investigator:	Janet A. Minch, M.A.	
Status:	Completed	
Dates:	October 1976-October 1979	
Cost:	Annual \$43,924 RT Annual \$40,790	Projected Total \$124,816 RT % of Annual Total 93%
Annual Report Reference:	#13, Page 309, R-62 #14, Page 266, R-62	

OBJECTIVES:

1. Determine the state of the art in consumer involvement nationwide.
2. Demonstrate the feasibility of model programs of consumer involvement.
3. Explore feasibility of establishing a Consumer Involvement Center.

METHODOLOGY: The methodology for Objective 1 is to develop questionnaires based on information needs to assess Chapter 25 implementation and difficulties. One questionnaire, designed for use with state agencies, will survey the eighty-one general and blind programs. Another survey questionnaire will be designed to survey a sample of the over 2,000 consumer organizations of disabled persons, to determine their interest in and level of consumer involvement with vocational

rehabilitation agencies. A detailed statistical and analytical presentation of survey results will be included in the report as well as discussion of various models.

The Massachusetts Rehabilitation Commission provided funds to explore models of consumer involvement in Massachusetts. Consumer organizations were selected to provide a program service component available to the rehabilitation agency and its clients and a structure for policy consultation to focus on issues of importance to the disabled community. Contracts are agreed to between Tufts and the consumer organizations. Technical assistance and grants management are functions provided by the staff of RT-7. Two model types, Individual Policy Consultation and Consumers as Citizens, are provided directly through Tufts RT-7 to the rehabilitation agency. Program assessment and evaluation will be undertaken by consultants and Tufts program staff. Emphasis is placed on expected outcomes and measures of the degree to which these are realized through program efforts. A final report will detail project methodology of the first nine months of the program. Follow-up evaluations will clarify how the program changes over time.

The methodology for Objective 3 is to involve persons with expertise and experience in the issues facing disabled persons as recipients of service to discuss and explore the feasibility of a Consumer Involvement Center. Through brainstorming sessions, literature and research review, analysis of training needs and roles will be isolated. If determined feasible, a small group of persons would work together to determine the basic structure and specific objectives of the Center. It would involve national recognized leaders, such as Harold Remmes, Frank Bowe, Fred Fay, and others who have personally undertaken activities in this area and who will share information and train others. The Center would have particular capability to serve as a clearinghouse for consumer involvement information, continue ongoing selected efforts that originate within the core area, provide training and technical assistance and other service programs as feasible.

The core area on Consumer Involvement at Tufts RT-7 will work with several Research and Training Centers to assist disabled persons representing organizations and individual leaders of disabled persons to come together to discuss coalition development. Tufts RT-7 will research the feasibility of coalition development, develop the materials, and provide training in consultation with the American Coalition of Citizens with Disabilities (ACCD) to assist RT Centers that desire to host a Coalition Building Conference within their region for disabled individuals. The program session will extend one evening and two full days. The program will cover the following areas: (1) the impact of coalitions at all levels: national, state and local; (2) sensitivity towards and working with other disabled persons; (3) how to develop a coalition, and (4) reasonable expectations for coalition growth. The program under development is similar to the one that was held in Houston, Texas in February 1978 through RT-4.

FINDINGS TO DATE: Findings to date for Objective 1 indicate that although each state vocational rehabilitation agency should have had a written plan formally describing its consumer involvement activities no later than December 31, 1975, only half of the agencies had such a written plan at the time of the survey. Furthermore, many essential aspects of the consumer involvement process were not always formalized in the written plan.

These aspects include:

1. The methods used by state vocational rehabilitation agencies to communicate with specific recipients and consumer organizations.
2. The methods used by agencies to ensure the recommendations of consumers are heard.
3. The payment mechanisms used to implement federal reimbursement provisions.

in the demonstration model project, objective two, the second year evaluation report draws the following conclusions and recommendations for consumer involvement programs in state rehabilitation agencies.

Continue and Expand Development of Advisory Councils Throughout the State

- a. Develop a method for Council members to communicate and share information at regional or statewide meetings and semi-annually.
- b. Establish a reporting mechanism for Council activities for sharing among the Councils.
- c. Provide written information on how to define and prioritize objectives.

- d. Provide written suggestions on issues and subjects for action by Councils.
- e. Adequately finance the Advisory Council activities at all levels.
- f. Provide for support services such as interpreters, personal care attendants and accessible meeting sites.

Formalize Areas of Policy Issues for Interaction with Consumers

- a. Initiate discussion meetings for exchanging views and policy issues between consumers and state agency personnel on rehabilitation issues.
- b. Disseminate written information on agency and consumer positions on rehabilitation issues.
- c. Disseminate and periodically review the state agency Policy Manual by the Advisory Council members.

Expand Consumer Based Services

- a. Formalize and financially support peer counseling programs throughout the state.
- b. Expand the capability of the Information Center.
- c. Encourage the hiring of consumer consultants.

Develop Training in Consumer Involvement Program and Skills

- a. Develop skill based training for use by agency and consumers in Council participation such as how to chair an effective committee meeting, how to set goals and objectives, how to organize active committees, how to be an effective leadership, how to problem solve, how to be assertive, etc.
- b. Training should involve state agency staff and consumers in all phases (planning, implementing and evaluating).
- c. Utilize consumers as trainers.

During the fall of 1978, one focus area of activity for the Consumer Involvement core area, objective three, under consideration was the development of coalitions. Through supplemental funding from the Rehabilitation Services Administration it was possible to explore an approach to coalition development activities. A coalition questionnaire was developed and sent to 21 organizations. The return of 67% of the questionnaires found that coalitions are most concerned with two issues: (1) funding, and (2) the need for training in the area of organizational development.

Three coalition development conferences were co-hosted with RT-2, University of Minnesota; RT-6, Emory University; RT-10, University of Colorado. A fourth conference was sponsored by RT-7 for the New England Region. A manual describing the organizational models of the existing coalition and their activities was prepared as a segment of the training materials developed for the conferences.

APPLICABILITY: The findings of this project will be of direct interest and benefit to disabled persons, state rehabilitation agencies, federal rehabilitation services administrators and others interested in consumer involvement programs. It will be useful for rehabilitation program planners, implementors and evaluators. Clients of rehabilitation agencies should find the information useful for understanding and participating in state rehabilitation agency activities.

117 Follow-Up Study on Vocational Rehabilitation - Outcome of Patients Discharged from the Rehabilitation Institute

Principal Investigator:	Martha Bernad, M.S.	
Status:	Completed	
Dates:	November 1976-December 1977	
Cost:	Annual \$3,096 RT Annual \$2,348	Projected Total \$14,741 RT % of Annual Total 76%
Annual Report Reference:	#13, Page 40, R-63	

OBJECTIVES: This study will examine and obtain answers to the following question :

What is the level of vocational activity of patients 18 months after discharge from a Rehabilitation Institute?

METHODOLOGY: The study, a collaborative effort of the Rehabilitation Institute and the Research Unit of the Massachusetts Rehabilitation Commission, will examine patients (18 months after discharge from the Rehabilitation Institute). The study population is drawn from the list of all patients discharged between January 1, 1975 and December 31, 1975. A questionnaire will be completed by telephone interview, since information sought does not require face to face interview.

Data Analyses: The questionnaire data will be coded and analyzed in conjunction with the functional assessment data (Barthel, Pulses). Pearson correlation will be used for analysis of functional assessment scores on Barthel, vocational functioning, and functional assessment scores on Pulses and vocational functioning.

Biserial correlation will be used to look at relationship of functional assessment Barthel score and contact with Massachusetts Rehabilitation Commission, and functional assessment Pulses score and Massachusetts Rehabilitation Commission contact. Biserial correlation will be used for analysis of functional assessment Barthel score and Pulses and contact with Rehabilitation Institute counselor.

Chi Square analysis will be used to determine if there is significant association between presence or absence of Massachusetts Rehabilitation Commission counselor contact and presence or absence of client satisfaction. Chi Square analysis will be used to determine if there is significant association between presence or absence of Rehabilitation Institute counselor contact and presence or absence of client satisfaction.

Chi Square analysis will be used to look at relationship between contact with Massachusetts Rehabilitation Commission and Rehabilitation Institute counselor.

FINDINGS TO DATE: Every consecutive inpatient seen in the rehabilitation center for a period of twelve months was contacted for telephone interview eighteen months after first discharge. Of 162 patients, 119 responded. Barthel and Pulses scores had been obtained at time of discharge. These scores were correlated with level of vocational activity at time of contact. Satisfaction scores were derived from the interview and correlated with contact by counselor. Results indicated a significant correlation between amount of Tufts contact and client satisfaction with Tufts ($r = 0.32$, $ps.03$). Fourteen percent were employed or homemakers, 24 percent were in vocational training, and 62 percent were either retired or unemployed. Barthel predicted for employment or homemaking ($r = 0.18$, $ps.02$), whereas Pulses showed no relationship with outcome. Implications for counseling services for medical center patients were drawn.

In reviewing level of functioning correlates with vocational activity, patients with higher Barthel scores had higher vocational functioning. RT code was found to have high correlation with Barthel. Thus patients with higher RT code tended to have higher Barthel scores.

RT code was significantly positively correlated with age as well as negatively correlated with work. The majority (93%) reported medical difficulties as the major obstacle to return to gainful activity.

In examining Massachusetts Rehabilitation Commission's involvement with the patient we found that if patient came in contact with MRC then they were more likely to come in contact with Tufts counselor. Results showed that more MRC contact led to more satisfaction with the agency. Contact with Tufts was highly correlated with satisfaction with Tufts and also with contact between MRC and Tufts. Thus, more Tufts contact resulted in more satisfaction and also more correspondence between the two counselors. We found a negative correlation between MRC satisfaction and contact between MRC and Tufts. This implies that when the patient was not satisfied, there would be more contact between the two counselors; the two counselors are more likely to communicate about dissatisfied patients than satisfied patients.

The less satisfied Tufts patient is more likely to be the male. Older men are less likely to be in gainful activity (maybe more females are homemakers) thus maybe looking for more services and not satisfied with what they can get.

Findings suggest that more contact between the two agencies leads to more satisfaction. It is recommended that MRC counselors follow hospitalized patients closer, or in the newly injured

patient the counselor should be involved as early as possible. It is also recommended, in future studies looking at vocational rehabilitation outcome of severely disabled persons after hospital discharge, that researchers use a combination of functional, vocational and social assessment.

APPLICABILITY: The findings can be used by rehabilitation personnel in gaining an understanding of factors which influence vocational rehabilitation outcome.

118 Development of Training Curriculum for Consumer Trainers

Principal Investigator:	Janet A. Minch, M.A.	
Status:	Completed	
Dates:	November 1977-October 1979	
Cost:	Annual \$61,198 RT Annual \$57,000*	Projected Total \$61,198 RT % of Annual Total 93%
Annual Report References:	#13, Page 342, R-70 #14, Page 280, R-70	

*Includes 1976-77 Supplemental Money.

OBJECTIVES: The substantive problem to which we address this project is twofold: to prepare disabled leaders of consumer organizations to advocate effectively through **content** (what to say to business personnel) and **process** (how to achieve a positive impact in an efficient manner) so that businessmen will remove unnecessary barriers to disabled people in the community. The focus will be particularly upon businesses which offer products and services directly to individuals in a community, such as supermarkets, department stores, theaters, and sports recreation facilities.

1. To select where possible and prepare where necessary materials geared toward disabled individuals in the area of consumer education and consumer affairs. (separately funded)
2. To select where possible and prepare where necessary materials on effective techniques of encouraging action by persons in positions to effect change: in this case, business personnel.
3. To select where possible and prepare where necessary materials on laws, regulations, cost-benefit data, effective techniques and resources relating to barrier removal. (separately funded)
4. To prepare a curriculum for training disabled leaders and other disabled individuals in consumer education and consumer affairs. (separately funded)
5. To prepare a curriculum for training disabled leaders and other disabled individuals in effecting change.
6. To prepare a curriculum disabled persons can use in training business personnel in removing barriers to access by disabled individuals.
7. To train 6 disabled leaders in content and process, as a pilot.
8. To package the training materials and procedures for use in other locales through other RT Centers.
9. To tap the resources of RT Centers as regional instructional centers acting in concert to alleviate a serious rehabilitation problem.

METHODOLOGY: The proposed project will produce a set of high quality instructional materials. The materials will be designed by project staff and produced at RT-15 under the supervision of Joseph Moriarty, Project Director (RT-15). Mr. Schwartz, a media and materials specialist with private business background, will be responsible for drafting the materials and curricula, reviewing existing materials and curricula for possible adaptation or adoption, and determining an appropriate balance between project produced and currently existing resources. Sixty (60) disabled leaders selected from among officers and members of consumer organizations in Regions I and II will be invited to attend the two-day workshops to receive training and to provide the project with an opportunity to pilot test its materials and curricula. Evaluation, both objective and subjective, of and by participants, will be applied toward revision of project products prior to dissemination for the second year's activities.

We expect to produce the following kinds of materials:

Tufts University

1. Pre-workshop mailings acquainting participants with consumer education and consumer affairs;
2. self-instructional guides for participants to use in acquiring and reviewing techniques of effecting change in attitudes and actions of significant others;
3. slide shows and lectures accompanying the slides on barrier existence and removal;
4. pre- and post-tests;
5. participant evaluation forms;
6. post-workshop mailings on additional materials and issues.

Information from an Office of Education project will offer in-workshop materials on consumer education and rights as disabled citizens.

The procedures we will follow in the workshops stress participant involvement through active learning. We will structure role playing sessions on effecting attitude and action change among significant others, simulation training (to help participants understand and appreciate other disabilities and the barriers obstructing persons with these impairments), self-instructional readings, and small group sessions emphasizing participant involvement. Additionally, lectures and slide shows will be used.

By selecting participants from organizations of disabled people in the two regions, and by asking the organizations to nominate participants who will be held responsible for training members subsequent to the sessions, we are establishing the base for the trainees to become trainers. ACCD will supply additional sets of materials and resources for each trainee upon provision of documentation that he/she will teach a specified number of individuals in his/her organization.

The project will establish an advisory panel of eight individuals, at least two of whom will be from private enterprise, one from education and media, and four from organizations of and for disabled individuals. The advisory panel will review project plans prior to drafting of materials and curricula and again prior to actual production of final copies.

FINDINGS TO DATE: In February, 1979, the materials for the "Advocacy in the Community" workshops were completed: (1) a **film** entitled "American the Beautiful," designed to assist the trainees in understanding how to approach and make an appropriate impact on local business people; (2) "Project Green Light Access: A Workbook for Change Agents," **self-instructional guide** which enables workshop participants to review key ideas and assists trainees in preparing others to advocate for barrier removal; (3) a **barrier slide/tape show** to provide trainees and persons they train with a presentation they may use with a business person; and (4) a **brochure**, "Green Light Access," which reinforces the slide/tape presentation and provides the trainee with a handout to give business people after a discussion/lecture.

In March invitations to attend a pilot workshop in Danvers, Massachusetts, were mailed to the Directors of 350 consumer organizations for disabled people throughout the New England states. Thirty trainees were selected to attend the 2½ day pilot session. The second pilot workshop convened prior to the ACCD national delegate meeting. Board members of ACCD participated in the training. Members of consumer organizations from all over the country joined in the workshop at the second session. Participants felt it would be very helpful to share information (techniques that work, changes made, reaction of individuals, etc.) as the action at the local level develops. Several noted that continuing availability of materials is essential for successful impact at the local level. The segment of the program that most participants personally benefited from was how to approach business people in order to help them to understand accessibility and how to make their business more accessible to people with disabilities and the entire community.

From pilot testing, suggestions for refinement of materials were made and are being undertaken. Materials have been prepared for use by a variety of consumers (on tape, captioning, large print, etc.). Costs of program activities at a local community level have emerged as an area of concern of implementation. Several persons testing the materials have found local community groups supportive.

APPLICABILITY: A major area for change from this project will be for the disabled consumers who are trained through the program and/or participate at a local level in activities stemming from the program. Some of these consumers will be clients of vocational rehabilitation. A model program of this type will provide a focus of activity for consumer organizations that take an active role in developing the program in their local communities. It should assist in organizing these groups

who in turn can help to bring change to the accessibility of the business environments. It is anticipated that the practices of local businessmen through awareness and education, when regulations don't exist, will be responsive to making accessibility changes. These changes certainly are most important to the independent living needs and vocational goals of the vocational rehabilitation client.

119 Auditory Feedback as it Relates to Language Acquisition and Utilization with the Severely Physically Disabled (Tufts-Talking-Typewriter-Trainer/T-T-T-T)

Principal Investigator: Hubert L. Gerstman, Ed.D.
 Status: Continuing
 Dates: July 1976-October 1979
 Cost: Annual \$28,195 Projected Total \$124,808
 RT Annual \$27,045 RT % of Annual Total 96%
 Annual Report Reference: #13, Page 148, R-58

OBJECTIVE: The objective of the study is the creation of a new Tufts-Talking-Typewriter-Trainer with a TIC as a core.

METHODOLOGY: The methodology includes the design of the prototype device using the laboratory computer (PDP 11/20), a Votrax VS-6.4 voice synthesizer, and various interface systems made available through other RTC communication projects. The system accepts a phonemic input from one of the interfaces and displays that phoneme graphically on a video monitor. Simultaneously the synthesizer responds with the spoken utterance. Following a "space" selection, the synthesizer speaks the word by joining all of the previously chosen phonemes.

Once the hardware has been tested, a procedure for training is implemented. The Goldman-Lynch sounds and symbols set has been chosen. The orthography of the set is compatible with the video monitor, and the curriculum is well documented for teaching to the project subjects.

Several subjects will be taught to use the system in order to observe its effects upon the communication procedure.

FINDINGS TO DATE: To date, the computer prototype has been made operational. Three subjects were trained on the system using a modified Goldman-Lynch Curriculum. Results are below. Also of importance has been the development of modifications to standard language tests. The Carrow and Peabody test have been successfully modified to allow for minimization of error due to motor dysfunction.

Each of the three subjects was tested for hearing loss with a routine pure tone audiometric screening. Each had no difficulty in passing the test.

The Modified Peabody Picture Vocabulary Test-Form B (Measures comprehension of single word spoken vocabulary) and the modified Carrow Test for Auditory Comprehension of Language (measures language meaning via the Lexicon (vocabulary) and structure (grammar and syntax)), were administered to the subjects. The results were as follows:

subject	chronological age	mental age (Peabody)	mental age (Carrow)
KC	10-0	4-11	6-6
RS	11-10	4-4	6-9
FG	24-4	8-9	5-9

The pilot program was scheduled for approximately a 3 month period with hour sessions 3 times per week for each subject. The number and length of sessions and the number of phonemes introduced varied depending upon attention span, transportation difficulties, absenteeism, learning skills, etc. During the initial sessions, the basics of the machine were taught and reviewed, i.e., tracking of the light, scanning, left to right sequencing, lever control, same/different (concept), blending of phonemes, etc. Each subject was evaluated for motoric control, and was equipped with a single switch interface which was used to operate the scanning input device.

Conclusions: The pilot evaluation was concluded at the scheduled time (end of three month period). This is not an indication that the program was finished, nor is it a sign of failure. The results are quite encouraging. They support the original contention that auditory presentation or feedback is useful in augmenting the expressive language capabilities of a nonvocal individual. The two younger subjects have shown considerable potential for making use of such a system. The staff at the Massachusetts Hospital School has agreed to continue the use of Goldman-Lynch symbols with a teacher providing the auditory feedback. This will be satisfactory until such time that funds are located to reproduce the laboratory system at the school.

The one relatively unsuccessful subject provided a reasonably good profile of an individual for whom auditory feedback would not be appropriate. Her scores on the screening tests were not sufficient to make that determination. Early performance on the Goldman-Lynch program does however, provide some clues which are thought to be relevant.

APPLICABILITY: It is hoped that the results of this project will lead to an improvement in expressive language in the nonvocal individual. This project is seen as a basis from which further studies in language (Ref. Project R-69) and voice synthesis (Ref. Project R-68) can continue.

120 Comparison of Outcomes of Obese Diabetics to Obese Non-Diabetics After a Multidisciplinary Program of Alteration of Preventive Health Behaviors

Principal Investigator:	Theresa A. Hoskins, R.P.T., M.S.	
Status:	Continuing	
Dates:	July 1976-September 1980	
Cost:	Annual \$16,194 RT Annual \$7,791	Projected Total \$79,087 RT % of Annual Total 48%
Annual Report Reference:	#13, Page 387, R-65	

OBJECTIVES:

1. To determine outcome differences between two groups of obese subjects: diabetics and non-diabetics, after a multidisciplinary program for the alteration of their preventive health behaviors.
2. To measure outcomes of all obese subjects involved in the multidisciplinary program, in terms of physiologic change (aerobic capacity), physical change (weight loss and body composition measures), metabolic change, (fat or carbohydrate substrate utilization), vocational or avocational change, and behavioral change (eating and activity behaviors).
3. To compare motivational factors in the two groups of obese subjects toward altering their preventive health behaviors.
4. To clarify the barriers, emotional or physical, which prohibit appropriate alteration of preventive health behaviors.

METHODOLOGY:

1. Screening of all obese subjects referred by physicians for a program of weight control was done on the basis of dietary history, body weight (20% over ideal), exercise tolerance, emotional suitability, and compliance with an individual diet over a preliminary four week period.
2. A written contract was written and signed by each person and each staff member.
3. Group behavior modification sessions were held once per week and group exercise sessions three times per week.
4. Behavior modification for weight control consisted of daily eating and activity records, the identification of eating cues, habits which encourage over-eating and factors in the social environment which lead to over-eating or under-exercising. Elimination or substitution of maladaptive behaviors and environmental modifications were suggested. Relaxation techniques were taught. Videotaped simulation techniques were used to introduce issues confronting dieters.

5. Measures at the end of the contract period include changes in eating behavior, compliance with diet, weight loss, body composition changes, aerobic capacity, activity questionnaire.

FINDINGS TO DATE: Twenty-six percent of the population enrolled in this program completed it successfully. Fifty percent of these were diabetic.

Diabetic mean improvement in aerobic capacity is +.78 L/min O₂, while non-diabetic mean improvement is +.95 L/min O₂. Diabetic mean weight loss is -8.85 Kg, while non-diabetic mean weight loss is -7.41 Kg. Diabetic mean axillary girth measures were reduced by 2.04 inches, while non-diabetic mean girth reduction was 5.40 inches. Diabetic mean systolic blood pressure was changed by -6.2 mm Hg, non-diabetic mean systolic was changed by -3.1 mm Hg. Diabetic mean diastolic blood pressure was changed by -4.0 mm Hg, non-diabetic mean diastolic blood pressure was -2.4 mm Hg.

Follow-up on the people who completed the program successfully show:

	Diabetic Current Status	Non-Diabetic Current Status
No further contact	3	5
exercising self	7	6
sought more help for weight	1	0
co-morbidity developed later	2	1
number employed	9	8

APPLICABILITY: The results of this study should provide information useful to other rehabilitation facilities and clinics where exercise can be made an integral part of an approach to treatment of obesity. Information about the problems diabetics have relative to those non-diabetics have in their efforts to lose weight have been relatively unavailable. These findings can be applied to a variety of settings.

121 Development of Functional Eye Movement Communication System

Principal Investigator:	Richard Foulds, M.S.	
Status:	New	
Dates:	November 1978-May 1981	
Cost:	Annual \$38,942 RT Annual \$36,009**	Projected Total \$100,826 RT % of Annual Total 92%
Annual Report Reference:	#13, Page 183, R-66	
**Includes R.E.C. Supplemental Funding		

OBJECTIVES: The major objective of this project is to develop and test a line of sight communication system that can be operated by a severely physically disabled individual. The initial portion of the program will focus upon the development of eye orientation, head position and orientation equipment, and the computer algorithms that will result in the composite line of sight.

Data from this portion of the project will lead to the specification of the parameters of a portable system. Two such system prototypes will be developed and field tested.

METHODOLOGY: The project is divided into three major phases. The first phase involves the development of both the hardware and software required to establish a laboratory line of sight communication system. This phase consists of three subparts, the design of an interface between the user and the corneal reflection monitor, software control of the system timing and output devices such as auditory and visual feedback and the development of a calibration routine requiring a minimum of user involvement.

The second phase is an evaluation of the usefulness of such a device with disabled individuals. The final phase will be to define the parameters for the design of a clinically usable device.

Basic Technique: The underlying approach to computing line of sight will be that of monitoring

angular rotation of the eye, as well as monitoring the orientation and position of the head.

A review of eye orientation systems by the investigators has resulted in the selection of corneal reflection as the method of choice. The targets for the system will be placed within the environment in known locations. An indication of the selection of one of the targets will be available when the line of sight (defined by the straight line equation) intersects the location of the target.

Corneal Reflection Apparatus: The investigators have chosen an optical system which has high resolution. The optical element is a 100 x 100 charged coupled device manufactured by Fairchild. The unit is incorporated into a sensing system with appropriate electronics by Solid State Sales of Cambridge, Massachusetts. This system will be constructed and modified so as to be wearable on an eyeglass frame and with custom molded bridge structure to minimize shifting of the frames. The corneal reflection will be created by a small infrared light source also fixed to the glasses frame.

The corneal reflection signal monitored by the CCD array is subjected to a number of possible sources of error. Erroneous inputs can be reduced by properly orienting the monitor and IR emitter with the eye.

All control and timing for scanning the 100 x 100 array is performed by the computer. The recognition of the corneal image is processed and filtered in the computer to filter out noise inherent in the circuitry.

Head Position and Orientation System: The laboratory apparatus will monitor head position and orientation by means of an ultrasonic ranging system. The particular apparatus to be employed in this project will be a three dimensional Graf Pen manufactured by Scientific Accessories Corporation.

Three transducers are to be attached to the head, two are mounted on the eyeglass frames, which contain the corneal reflection receiver, one is mounted on a band passing over the top of the head. Transmitters are sequentially triggered under control of computer and distance of each transmitter to all four microphones is stored in the computer.

Information is processed by the computer to define the position of the head. The head's orientation is represented in terms of a vector equation which defines the origin and direction of the head.

Target Detection: The two subsystems, Eye Position and Head Position are designed such that vector equations define both the eye's and head's orientation in space. Addition of the two vectors renders a summation vector which defines the subject's line of sight. This vector is then solved simultaneously with the equation defining the object plane. The resulting point in the surface of the object plane is the coordinate at which the subject is fixating.

This calculation is repeated approximately 40 times a second and resulting intersection point is analyzed statistically to ascertain the points validity as a line of sight intersection.

To compensate for the fluctuations in the corneal reflection due to the movement of the sensing instruments, system calibration is then performed many times a second. This approach will serve to maintain the systems calibration for a more prolonged period.

A Communication System: The targets from above will be replaced with communication messages. Initially the messages will be individual letters of the alphabet. This will result in an optical typewriter. The actual selection of the target will be made by fixating on the target for a set period of time. Parameters relating to that fixation time will be determined.

Ocular Controlled Vocal Output: The laboratory system will be programmed to identify 500 targets. Each of the targets will be defined as a phonetic element (phoneme, syllable, or other combination of phonemes) as defined by Trepagnier. The output will consist of the spoken utterance via a model VS-6.4 voice synthesizer (Votrax) that is attached to the BMEC computer. Additional output will be provided through a video graphic terminal.

Experimentation with this system will consist of measurements of the rate of communication made possible by the line of sight system. The viability of the syllabary will be tested in another project in this report.

FINDINGS TO DATE: Activities have focused on developing the eye position monitor hardware and interfacing this into the main system. Substantial research and experimentation has been performed

to develop a user oriented line of sight communication system.

Software programs have been written to perform the initial calibration of the system for the user. These will, however, be revised and improved to decrease and simplify the degree of user involvement in the calibration routine.

APPLICABILITY: When incorporated with a syllable based communication system, this technique offers the potential of rapid communication rates that could theoretically reach 60 words per minute.

122 Development, Testing and Application of a Phonologically-Based Communication System for the Non-Vocal

Principal Investigator: Cheryl Trepagnier, Ph.D.
Status: Continuing
Dates: December 1977-December 1983
Cost: Annual \$41,451 Projected Total \$215,545
RT Annual \$38,633** RT % of Annual Total 93%
Annual Report Reference: #13, Page 219, R-69
**Includes R.E.C. Supplementary Funding

OBJECTIVES: The purpose of this research is to develop and test a language component for non-vocal communication which can be implemented with any type of hardware, which will have the following two features:

1. access to all of language: that is, the capability of producing any and all words of English.
2. maximum efficiency: that is, messages are produced by means of the smallest possible number of acts (pointing gestures, switch closures, etc.) per word.

METHODOLOGY:

1. Studies of the distribution in spoken English of sequences of phonemes. Phoneme sequences will be chosen for their frequency and combinability. Different algorithms to produce the ideal set of phoneme sequences will be compared for the "efficiency" of their result. Efficiency is defined as the number of unit (phoneme sequence) selections required per word to produce a test corpus.
2. Refinement of system, development of a simplified orthography. The system will be realized in pointing board and Etran formats. It will be tested with speaking subjects.
3. Selection and screening of non-vocal subjects. Subjects will be paired, based on similarity of scores in screening tests, age, and academic level. Development of training materials.
4. Training in system. Experimental Subjects will receive intensive training in this system, while control members of pairs will spend same amount of time in communication practice using their current communication mode.
5. After a 6 month period, language of all subjects will be reevaluated. Controls will then begin training in this system. After a second 6 month period language evaluation will again be carried out. Comparisons will be made between experimental and control subjects, and between pre and post-trained control subjects, in order to assess the effect of learning this system on language performance.
6. Messages produced by subjects in the course of training and practice with the system will be noted and analyzed. Error analysis will provide useful information both for adjusting the system and for improving the training techniques. Linguistic analysis of subjects' production will provide insight into productive language abilities of the non-vocal.
7. Comparisons will be made between non-vocal language development of speaking children.
8. The language data obtained from non-vocal subjects will provide the basis for development of materials designed to enhance language development and encourage language use.
9. Materials for communication enhancement in very young children will be devised, making use of the data obtained on non-vocal language acquisition.

FINDINGS TO DATE: A corpus of 250,000 words of spoken English, on computer tape has been obtained and transcribed into Webster's dictionary phonetic script by means of a Webster's dictionary on tape, plus numerous rules to handle inflected words.

An algorithm has been developed which selects units according to: (1) frequency, (2) left-to-right processing and (3) nonintersection. The resulting sets of units appear to provide efficient representation of English. However, efficiency remains to be measured.

An orthography which seems to be readily comprehensible by readers of English is being tested.

Other algorithms have been devised and await programmer and computer availability to be tested. Efficiency of the results of these procedures will be compared.

Arrangements have been made for large scale testing of the system in three Boston area institutions, as well as pilot testing of the system with a non-vocal user. Formal evaluation has not yet been undertaken.

APPLICABILITY: In the past, non-vocal individuals have often been diagnosed as cognitively and linguistically deficient, while it is possible and indeed likely that it is not native potential which they lack, but rather that non-vocal individuals, severely motorically involved, suffer from extreme experiential deprivation. Language acquisition requires exposure to the data of language and the ability to test unconscious hypotheses about grammar, including phonology, syntax and semantics, and communication. Cognitive maturation seems to require the same kind of access to the data of experience and the possibility of acting upon it - directly, by manipulation, or indirectly by language and thought experiments.

The motorically limited, mute child is deprived both in what aspects of the environment are available to him and in ways he can act upon it.

Early training in a non-restrictive and rapid communication mode should promote an increase in the amount and quality of language to which the non-vocal child is exposed, as well as giving him more opportunities to test his notions about language and the world. It will constitute an important step towards enriching the non-vocal child's environment and his possibilities of interacting with it and exerting control over it.

Participation in his environment rather than passive observance of it, will have benefits for language and cognitive development, as well as the development of attitudes and behaviors that will enhance the non-vocal child's possibilities of realizing his human potential.

123 Voluntary Control of Autonomic Functions by Spinal Cord Injured Persons: A Practical Application of Biofeedback in the Treatment of Hyperthermia and Postural Hypotension

Principal Investigators:	E. Gaddis, M.A. T. Hoskins, M.S.	
Status:	Continuing	
Dates:	November 1977-October 1979	
Cost:	Annual \$35,955 RT Annual \$33,062	Projected Total \$104,761 RT % of Annual Total 92%
Annual Report Reference:	#13, Page 397, R-72	

OBJECTIVES:

1. To determine the ability of spinal-cord-injured persons to voluntarily control such functions as blood pressure, skin and core temperature, and sweat production.
2. To identify factors useful to these patients in achieving such control: biofeedback, imagery, relaxation, autogenic exercises, internal and external incentives, classical conditioning.
3. To train spinal-cord-injured persons to use successful techniques under the stressful conditions of hyperthermia, postural hypotension, and hypertension associated with dysreflexia.

METHODOLOGY:

1. A thorough review of related research on learned voluntary control of autonomic functions was completed.
2. Questionnaires were sent to researchers and to spinal-cord-injured persons to assess the problems under investigation and to aid in experimental design.
3. Initial experiments on temperature and blood pressure control have been designed, utilizing biofeedback equipment (pulse-wave velocity, SPR and GSR, temperature feedback). Baseline measurements are being taken for each variable. Various techniques are being explored to determine their effectiveness in controlling these variables.
4. An experiment using iontophoresis with pilocarpine to stimulate sweat glands is being done with six quadriplegics and six normals as a control group. Quantitative sweat measurements are obtained by pre- and post-measurements of gauze and plastic wrapped over the area stimulated by pilocarpine. Areas stimulated include shins, forearms, and back of neck. The neck site represents a control for the quadriplegic as it is above the level of lesion, and one shin without the pilocarpine treatment serves as a control for both groups. Comparative measurements may indicate the intactness of the quadriplegics' sweat glands and will offer baseline material for the following experiment, which will measure the amount of sweat from the same areas under thermal stimulation. These experiments will give us an indication of how useful the conditioning of sweating could be in helping a spinal-cord-injured person control hyperthermia.
5. A pilot study will be designed and carried out after data is analyzed from the above experimental investigations. Quadriplegics will be trained to voluntarily control blood pressure and temperature utilizing those techniques proven most successful in the initial experiments.

FINDINGS TO DATE: Six normal and six quadriplegic subjects have been tested for sweating with iontophoresis. Results show no statistically significant difference in the quantity of sweat for all sites between the two groups. Interviews with quadriplegics, with injuries more than eight years, indicated two types of patients. Some tolerate heat well and react poorly to the cold, while the reverse is true for others. Some patients have irregular sweating patterns such as sweating only on one side of the face. Postural hypotension may become a problem for these patients with long-term injuries, but is more prevalent in newly injured quadriplegics. Major concerns are with blood pressure control preceding/during autonomic dysreflexia.

APPLICABILITY: With the results from this investigation, we will be able to define the areas in which specific experiments need to be done in order to develop a practical rehabilitation-oriented program. Such a program would train patients to successfully utilize these techniques as an additional aid to independence in daily living. The results of the present project will be useful to the growing number of clinical and rehabilitation facilities that are using biofeedback and related techniques to train patients to achieve voluntary control over autonomic functions.

124 Integration of Independent Living into the Total Rehabilitation Process

Principal Investigator:	Paul J. Corcoran, M.D.	
Status:	Continuing	
Dates:	November 1977-October 1979	
Cost:	Annual \$72,322 RT Annual \$66,974**	Projected Total \$147,887 RT % of Annual Total 93%
Annual Report Reference:	#13, Page 60, R-71	

**Includes 1976-1977 supplemental money on 1977-1978 budget.

OBJECTIVES:

1. To measure the effectiveness and costs of a transitional housing program designed to "deinstitutionalize" the later phases of medical rehabilitation.
2. To measure the effectiveness and costs of using independent living trainers (ILTs) as a new service to impart independent living skills not ordinarily provided by rehabilitation professionals.

3. To measure the effectiveness and costs of using an educational model in the medical rehabilitation process to foster greater patient responsibility in managing his/her disability.

METHODOLOGY: The study population consists of severely disabled persons served by the Tufts Rehabilitation Institute. Project effectiveness will be measured on the basis of goals and outcome criteria relevant to each of the project's three components -- transitional housing, independent living training, and education. The measurement of project effectiveness draws upon existing Institute expertise in the area of functional assessment but also considers refined measures of functional independence that captures behavioral changes in areas such as outdoor mobility. The research design uses a pre-post comparison of patients served by the project.

FINDINGS TO DATE: Project experience to date has indicated that independent living trainers can often function more effectively as an extension of a consumer-based organization than as a full fledged member of the traditional rehabilitation team. The educational component of the study found that patients needed a comprehensive guide (developed in the form of a patient handbook) to help them organize the services and resources needed to live independently. The transitional housing portion of the study was not implemented since the university declined to acquire the needed site. The project's evaluation experience to date has demonstrated a need to critically evaluate traditional functional assessment measures that are not sufficiently geared to the measurement of independent living outcomes.

APPLICABILITY: The project speaks to many issues in rehabilitation today. New ways are needed to minimize the dependency inducing features inherent in the medical model and in the institutionalization and professionalism accompanying current medical rehabilitation practice. The medical rehabilitation environment is an artificial environment that cannot accurately simulate the real world to which the patient must return and function independently. Moreover, the economics of health care delivery make it necessary for medical rehabilitation programs to locate and test alternative service strategies to minimize hospital lengths-of-stay and costs.

125 Research in Posture and Support Orthosis

Principal Investigator:	Randall Fincke, M.S., Rehabilitation Engineer	
Status:	New	
Dates:	November 1978-October 1981	
Cost (Proposed):	Annual \$41,417 RT Annual \$35,336	Projected Total \$123,250 RT % of Annual Total 85%
Annual Report References:	#13, Page 254, PR-75 #14, Page 182, R-75	

OBJECTIVES: To identify the requirements of a seating system, and then categorize these parameters according to classifications of neurological impairments, and from this, a technique for standardizing the manufacturing process will be developed, so that labor spent in the final patient fitting can be held to a minimum.

The primary objective of this project is to decrease the labor required in manufacturing a supportive seat. Emphasis will be directed toward the application of more appropriate molding techniques and in selecting materials for their ease of manufacturing.

METHODOLOGY: During the early stages of the development, exploratory visits to other laboratories have been planned. These facilities include the Sick Children's Hospital in Toronto, and the Ontario Children's Center, Toronto. Evaluation of the University of Tennessee, Memphis' Modular Seating System continues. This evaluation has helped facilitate the development of our expertise in seating techniques.

Data collection and evaluation of existing seating systems will be based on the experiences of others in the field, as well as specifications drawn from the needs of individual patients seen at our facility. Support criteria is comprised of both the practical aspects of patient comfort and tolerance to support and the therapeutic potential of providing a particular support. A hierarchy

of seating requirements will be produced from this data for each of the neurological disorder populations (i.e., MD, CP, spinal cord injured, etc.).

By developing a relatively low-cost, cosmetically acceptable, and functionally effective support, we hope to establish an easily reproducible method of treatment for maintaining a straight spine. Wilkins and Gibson, at the Hospital for Sick Children in Toronto, have suggested that maintenance of Lordosis may be a key factor in preventing Scoliosis.

FINDINGS TO DATE: The large vacuum forming system designed earlier was modified and improved to provide more efficient use of material. Various grades of ABS and other thermoforming plastics were experimented with and tested. An evaluation of seating requirements was performed and criteria lists were compiled for three disabilities.

A variety of techniques are being employed to obtain a well defined body mold from which an orthosis may be constructed, including fiberglassing a customized mold. Polyurethane foam is being used in two different forms: (1) in an air-bag principal, and (2) in rigid form.

The correct selection and research materials have proven to be very effective in the success of developing a practical postural orthosis. By choosing the appropriate finish coverings it is possible to mold a compound curved orthosis as a single integral unit. This replaces the current technique of trial and error tailoring by hand, which is expensive, timely and not always accurate.

APPLICABILITY: Proper postural support increases functional independence by providing support to the client so that the abilities he/she does have can be better used. Without proper postural support many functional abilities are lost as the person uses all their energies to compensate for limited or absent support.

Increased functional independence through proper postural support includes increased ability for self-care, communication and employability.

The development of a low-cost postural support orthoses will make the system more readily available to a larger population of the severely disabled. As the use of postural support orthosis increases, decreased hospitalization and institutionalization can be expected as the complications related to poor positioning (i.e., scoliosis, respiratory difficulties) also decrease.

126 Application of Low-Cost Micro-Computer Systems for Communication Aids

Principal Investigator:	Andrew Thomas, B.S.	
Status:	New	
Dates:	January 1978-October 1979	
Cost:	Annual \$33,504 RT Annual \$32,584**	Projected Total \$63,000 RT % of Annual Total 97%
Annual Report Reference:	#13, Page 199, R-67	
**Includes R.E.C. Supplemental Funding		

OBJECTIVES:

1. The major objective of the project will be to construct a general purpose communication system using low cost video game technology. The new device will offer three programmable interface options to the user.
 - a. Tufts Interactive Communicator
 - b. Dictionary Mode
 - c. Anticipatory Mode
2. The goal of this phase of the project is to replace the expensive communication devices on the market with a low-cost system. The result will be increased availability of communication aids for non-vocal individuals, enhancing their vocational, educational, and social potential.
3. The last phase of the proposed project will be to develop a graphic symbol output device

using low cost video technology. The unit will have the capability of printing any black or white stick figure that is to be used in a communication system. The unit having a symbol capacity of 800 will accept inputs from previously designed or yet to be designed interfacing systems, and display selections on a video screen and/or hard copy terminal.

METHODOLOGY: The problem will consist of two phases: (1) construction of a low-cost programmable communicator, (2) development of a symbol printer.

Phase 1 includes becoming acquainted with private enterprise regarding production techniques; implementation of the proposed system using the low-cost ACA 1802 micro-computer system; development of a software package; development of a production model.

Phase 2 consists of developing a system that converts any symbol into a 32 x 32 DOT matrix, again using the low-cost RCA micro-computer.

FINDINGS TO DATE: Progress on this project was hampered somewhat by the resignation of the principal investigator in September 1978. A new principal investigator was recruited in May 1979. Activities during the transition period were primarily concerned with the functional configuration of the nonvocal communication device information accumulated in Projects 25 and 44 have been quite helpful. Feedback from users of communication device has also been of extreme importance.

Several manufacturers have renewed their interest in producing and marketing this micro-computer communicator. The Regional Advisory Council has supported the establishment of a committee to negotiate with the potential firms. The project staff is continuing to develop the final design, but will be able to discuss compromises with the ultimate manufacturer.

Phase two of the project is progressing with the purchase of a 32 x 32 photodiode array. This will be interfaced to a low cost Cosmal VIP Micro-computer game system. Pilot work will be done during the Fall of 1979 to determine correct character (symbol) size, and user operation.

Developments in both phases of this project will be greatly enhanced by the addition to the engineering staff of a nonvocal individual with experience in the area and interest in transferring that knowledge into this effort.

APPLICABILITY: The result of this project will provide private enterprise with communication devices using low-cost video game technology. With this high volume off-the-shelf components and considerably less labor involved in construction, manufacturers will now be able to increase the availability of these units as well as reduce their production expense. The flexibility in design will also allow future adaptations without major increases in cost.

127 Design of an Inexpensive Audio Message System

Principal Investigator:	Richard Foulds, M.S.	
Status:	New	
Dates:	November 1978-October 1979	
Cost:	Annual \$28,904 RT Annual \$27,322**	Projected Total \$48,400 RT % of Annual Total 94%
Annual Report Reference:	#13, page 211, R-68	

**Includes R.E.C. Supplemental Funding

OBJECTIVE: The objective of this project is to develop a low-cost audio tape storage unit that can be used in conjunction with existing communication devices. The system will be capable of storing up to 500 recorded messages of human speech which will be selectable by the user.

The unit will have the following features:

1. Less than 5 seconds average access time to the stored messages.
2. Acceptability of inputs from scanning, direct selection, and encoding devices.
3. Ability to be reprogrammed by the clinician using standard nontechnical methods.

METHODOLOGY: There exists on the commercial market an inexpensive tape transport which can be operated at high speeds of rewind, and fast forward. It can also be operated in "play" in either direction. The unit is also equipped with a photo optical counter which provides a fairly accurate position indication on the tape.

The Massachusetts Department of Education has provided funding for the placement of 8 of these units in special education classrooms in the Commonwealth. These units will be attached to the Symbol Tufts Interactive Communicator which will provide an input mechanism. The SymTIC is by no means the only device which can serve as an input to the tape recorder.

The initial devices constructed during the summer of 1978 store 56 messages which conform to the SymTIC format. The tape drives will be provided with discrete circuitry which will accept an input from the scanning unit. This input will select a position on the tape that is in the drive and the track on which it is stored. The messages will be stored in 28 consecutive locations on each of two tracks of a standard Philips tape cassette. The tape will begin to "fast forward" from the beginning of the tape (BOT). The circuitry will monitor the photo optical position indicator for the desired location. When the specified count is recorded, the unit switches into the play mode. Once the message is played, the tape will be returned to the BOT.

Upon completion of the design described above, the 8 units will be fabricated and placed in appropriate settings. The BMEC staff will observe the use of the devices and identify the parameters of a final design, meetings with the classroom teachers and clinicians as well as the users will provide valuable input.

The final stage of the project will be the development of a unit which will store up to 500 messages. The chosen tape transport has the capability of recording on 4 tracks. A method will be devised to calibrate the tape to the center of the tape after each message is "spoken." An inexpensive microprocessor (RCA 1802) will provide the processing. Engineering evaluation such as reliability, durability, and accuracy will be undertaken. At the time of successful completion, a manufacturer will be sought.

System cost including tape transport, circuitry and additional memory should be in the \$1,000 range. This is approximately the cost of a printing or display unit used in other communicators.

FINDINGS TO DATE: The following systems have been evaluated for speed of access, portability, intelligibility, cost and reliability potential: T-NEMC Tape Transport, Stanford Tape Transport, Votrax Handivoice, TSI Talking Calculator, McDonnell-Douglas Stored Speech Device and Scitronics Form-A-Phrase.

The principle differences between the T-NEMC and Stanford systems are the tape transport and the speed. The T-NEMC unit will use a standard sized cassette in comparison to the Stanford device which employs a miniature data logging system (Microvox), made in Waltham, Massachusetts. The Microvox is a continuous loop which must be run at real time. Each message must, therefore, play the entire tape (only the message desired is heard). Thus, if 500 messages are words on a tape, each selection must play the tape for the entire time for 500 words. The use of the more conventional tape transport allows for multiple track locations, thus reducing by one-fourth the distance traveled by the search. In addition, the bidirectional nature reduces that travel by another 50%. The fast search is on the order of 10 times the playing speed.

The quality of the recording is also superior in the cassette unit. The Microvox uses a miniature tape which was originally intended for digital data logging only.

APPLICABILITY: The use of human-like speech will be of great advantage to people in communicating specific messages in real time. This could be used in the employment of non-vocal people in situations where a few (on the order of 50) vocal responses can define the communication. Examples of this are jobs as a receptionist, teller, or telephone operator.

The device will also be of assistance in the educational setting where additional reinforcement of the efforts of the user are required.

128 Development of a Non-Distorting Transducer System for Measuring Pressure at the Tissue Cushion Interface

Principal Investigator: James P. O'Leary, M.S.
Status: New
Dates: November 1978-October 1980
Cost (Proposed): Annual \$24,414 Projected Total \$65,536
RT Annual \$22,286 RT % of Annual Total 91%
Annual Report Reference: #13, Page 271, PR-77

OBJECTIVE: The objective of this project will be to design and build an instrument which will accurately determine the pressure distribution under a seated or reclining patient. The transducer will be useful in evaluating equipment for the use of an individual patient, and is a research tool in the area of evaluating various seating and cushioning systems.

METHODOLOGY: The transducer requires two independent major developments to bring it to a reliable and efficient working condition. These two steps can proceed simultaneously.

1. A system to operate the transducer automatically is required. This will consist of a positive displacement pump, an electronic pneumatic pressure transducer and a valve array, all controlled automatically. The plan is to use an existing PDP 11 computer to control in the development stage. When this is fully workable, a microprocessor will be substituted to make the system portable.
2. The actual pressure transducer array needs further development to enable manufacture of a more uniform and reliable product. Latex dipping and laminating is one method being considered. Others may be sought.

The structure will by its nature be delicate and a repair procedure will also be developed.

When these two stages, to be undertaken simultaneously, are completed, the unit will be evaluated as a clinical tool in the fitting and prescribing of seating systems.

FINDINGS TO DATE: Activities have centered around construction of a prototype unit, and its application in a pilot study which has provided an opportunity to observe the strengths and weaknesses of the concept and the design when viewed as a working system.

The transducer element for the prototype was fabricated from polyethylene packaging material (bubble pack). This approach has the advantage of being readily available in a very acceptable physical configuration. Obtaining a reliable unit for the transducer in any other form appeared to be heavily burdened with tooling cost. The significant disadvantage is that polyethylene is difficult material to seal to other materials. Conventional adhesives, solvent adhesives and heat seals will not reliably hold.

Experience with the system was gained while running an experiment to study the effect of mattress construction on pressure distribution. The test was designed to enable the unit to determine the pressure profile under the sacrum of a supine subject. Three subjects were tested on eighteen mattresses-foundation combinations. It was learned from this that the theory and mathematics of the unit pose no real problems. With the electronic transducer there should be no problem in getting adequate accuracy. The problems in fabrication and reliability were pointed up by the test. It will be necessary to design a more easily workable valve system and to solve the sealing problems. The use of the fine tubing resulted in delays while pressure in the system equalized. The next prototype will use a larger tube to ease this problem.

Current efforts are aimed at solving these problems in fabrication. It appears that a unit may be made for individually fabricated polyvinyl chloride elements and assembled into the multiple unit array which is desired. This will have a number of advantages and should involve most of the current problems.

APPLICABILITY: The provision of a clinical system to evaluate pressure distribution should result in rehabilitation consumers obtaining seating systems which serve them better, resulting in increased mobility and longer periods of activity.

129 Dynamics of Communication with the Non-Vocal

Principal Investigator: Cheryl Trepagnier, Ph.D.
Status: New
Dates: November 1978-March 1981
Cost: Annual \$15,577 Projected Total Not Specified
RT Annual \$13,432 RT % of Annual Total 86%
Annual Report Reference: #14, Page 196, R-78

OBJECTIVES:

1. To observe and characterize the communicative interaction produced by non-vocal people representing a range of age levels, living situations and communication systems, with the "significant others" in their environment.
2. To record by means of questionnaire attitudinal factors which result from and act upon communication effectiveness, the vocal person's self-esteem and the attitudes and judgments of others about his abilities.
3. To devise, by means of these observations and questionnaire results, an evaluation framework for clinicians and researchers. This tool will be designed as a baseline measure, and as a follow-up measure as changes are introduced.

Application of these evaluation framework, to be called a "Communication Profile," will also provide a revealing diagnostic technique; it will be designed to point out problem areas in communicative interaction as well as relationships between the behavior of the speaking persons who make up the non-vocal individual's world, and his non-communicative behavior.

Both sides of the communication dynamics—that of the non-vocal person and the individual with whom he is communicating—will be represented in the profile and the outcome will be reflected in an "index of control," which will serve as an indicator of the non-vocal person's success as a communicator in his living/working situation.

METHODOLOGY:

1. Preparation of questionnaires to assess subject's communication frequency and spontaneity, subject's self-image, use of current communication system, subject's satisfaction with current situation.
2. Observation of subject's communicative interactions with others, particularly with respect to quantity of interactions and number of different people with whom they occur; nature of interactions (request for help, for information, expressing opinion, general conversation); and **outcome** of interactions (are requests met, for ex.).
3. Analysis of recorded language production with respect to syntax, semantics and pragmatics.

FINDINGS TO DATE: Locus of control scales (Rotter, 1966) are well-suited to our objective of measuring subject's self-esteem, and represent an area of personality that (we predict) will change following introduction of an effective communication system. The original Rotter scale has been adapted for use with individuals using communication devices, with respect to the content of questions that have been modified within and added to the original scale.

APPLICABILITY: The degree to which the user of a communication system or device perceives himself/herself as able to initiate verbal exchange, enlist the attention and conversation of others, affect their behavior, and be dealt with as an equal social participant will be reflected in his/her willingness to invest emotion and energy in his/her own social and vocational rehabilitation. Tools which the clinician can apply to assess the patient's communicative behavior will provide the basis for therapeutic efforts to affect the communication dynamics in which he/she and his/her significant others are engaged.

Improvement in the communication situation at an early age may well contribute to acceleration in language development, with attendant favorable consequences on education and rehabilitation.

130 Evaluation of Commercial Speech Recognition Device as an Aid to the Motorically Disabled

Principal Investigator: William Crochellere, Ph.D.
Status: New
Dates: November 1978-October 1979
Cost (Proposed): Annual \$13,172 Projected Total \$13,172
RT Annual \$9,320 RT % of Annual Total 71%
Annual Report Reference: #13, Page 290, PR-79

OBJECTIVE: The objective of this project is to explore the usefulness of a small and inexpensive speech recognition device that is currently marketed for \$250.00. This device was developed for the hobbyist computer market, and is compatible with commercially available microprocessor hardware. This device is small in size, and low in cost, and the manufacturer claims a high level of speech recognition accuracy. This study will address itself to:

1. Determining the actual reliability of the device to distinguish among the "words" in two low redundancy vocabularies: the spoken digits "zero through nine," and the spoken alphabet "able, baker, charlie . . ."
2. Improving this base level of reliability by fine-tuning the device to recognize the limited vocabularies.

Consideration will be given throughout the study to the eventual use of the device as a voice controlled typewriter, environmental control, and wheelchair guidance control.

METHODOLOGY: The Biomedical Engineering Center has obtained a SPEECHLAB manufactured by Heuristics, Inc. of Los Altos, California which will be used in conjunction with a controlling microprocessor to reach the project's objectives. Individual steps will include ordering and assembling hardware, research and determine command vocabularies; test and improve reliability of SPEECHLAB software; test the system by human subjects; reduce obtained data into final report.

FINDINGS TO DATE: A Z-80 microprocessor system was ordered. The system, including Heuristics SPEECHLAB board, was assembled and tested. Hardware and software problems were encountered and solved.

A speech recognition demonstration program was implemented on the system and tested with 10 subjects. The recognition rates ranged from 62% to 97% with an average of 80% correct speech recognition. The system was judged reliable, but sensitive to volume of spoken commands.

To eliminate the variability in human performance, a tape recording of commands was used. Recognition rate was determined to be 100%; no errors were made when the system tried to discriminate among ten tape recorded commands. Variation in recognition rates was therefore attributable to difference in the spoken word rather than the speech recognition hardware.

In the next phase of the project, alternate speech recognition algorithms will also be evaluated.

APPLICABILITY: The availability of a low-cost sound or voice recognition system will provide the intended users with an interface that allows them to use a controllable mechanism (speech). If this is successful, the use of vocal commands will provide more flexible and less physically demanding control of devices for communication, and environmental control.



**Temple University (RT-8)
Medical Rehabilitation Research and Training Center**

CORE AREA

Neurological and Neuromuscular Diseases

To advance practices and knowledge related to the rehabilitation of patients impaired by neurological and neuromuscular diseases through new initiatives for program activity such as participation in program development, execution and evaluation by handicapped persons themselves, and new concepts of impairment on disability such as the one developed by the World Health Organization.

TEMPLE UNIVERSITY

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COMPLETED

ABSTRACT NO.

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PROPOSED

Facilitation of Arm Movement in Disabled Patients with Stroke, Brain Injury, and Other Pathologies of the Central Nervous System	
Brain (Pariental) Tumors and CNS Functioning	
Involuntary Muscle Contractions in Spinal Cord Injury: Demonstration of a New Assessment Methodology Using Long-Term Observations of Normal and Abnormal Motor Behavior	
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131 Multi-Electrode Studies of Patients with Spastic Central Nervous System Disorders

Principal Investigator: N. Mayer, M.D.
Status: Completed
Dates: November 1974-October 1978
Cost: Annual \$40,647 Projected Total \$135,400
RT Annual \$40,647 RT % of Annual Total 100%
Annual Report Reference: #15, Page 182, R-141

OBJECTIVES:

1. To record EMG firing patterns from multiple muscle sites during arm movement.
2. To describe spatial and temporal characteristics of the EMG patterns with respect to arm movement for the purpose of movement classification.
3. To describe movement patterns of patients with spastic central nervous system disorders.

METHODOLOGY: Four hundred eighty three movements in four normal men ages 21-34 were studied. While sitting with the arm vertical, elbow at 90 degrees and forearm in neutral, each person gripped a pivoted rod which had a potentiometer mounted at its point of rotation to measure movement displacement. Subjects were asked to move the rod forward at widely differing self-generated movement speeds, all the while being careful to terminate forward movement at specified visual targets along side the rod. Surface EMG recordings were obtained from the anterior deltoid and the posterior deltoid by using a silver-silver chloride electrode, 9.5 mm in diameter, with a built-in preamplifier to eliminate wire noise. The raw EMG signal was band passed filter, rectified full wave, and subsequently fed to a PDP 11 computer (sampling rate=100 Hz) along with the displacement signal. An interactive computer program enabled us to specify the onset and termination of EMG activity and the onset and peak of movement displacement. The estimated observer reading error for this program was less than ± 15 msec. for the scaling factors selected. The computer then calculated maximum velocity and amplitude of displacement, movement time, and the duration of EMG bursts which were observed to end before maximum displacement had occurred. Distinction between burst patterns and continuous EMG patterns were made by visual inspection of each record.

FINDINGS TO DATE: In this study the anterior deltoid muscle serves as an agonist. In accordance with previous findings in the literature, we observed two characteristic electromyographic patterns in this study. One pattern was a continuous pattern where EMG activity began prior to displacement and continued through the peak of the movement, and a second pattern was a burst response where EMG activity began prior to displacement but gave way to a period of silence in the EMG trace prior to the movement reaching its peak. Independently of amplitude, burst patterns appeared to be associated with short movement times, the majority of bursts occurring at movement times less than 450 msec. The continuous pattern was associated with long movement times and only 1 out of 182 trials with movement time less than 300 msec. showed a continuous pattern. Burst duration time appeared to vary directly with movement time with the best fit straight line having a correlation coefficient of .81. Quick movements with shorter movement times had smaller burst durations across all amplitudes. At any one amplitude the number of burst patterns increased as the mean maximum movement velocity increased. It was noted, however, that the magnitude of the maximal velocity was larger in many cases of continuous patterns compared to burst pattern values when large amplitude movements were compared to small amplitude movements.

Activity in the antagonist posterior deltoid was seen most commonly in association with a silent period in the agonist anterior deltoid following a burst period. Antagonist firing was observed in 215 of 483 movements, corresponding to movement times ranging from 60-550 msec. across all four amplitudes. During the larger amplitude movements (25°, 50°, 75°), antagonist activity was consistently seen when movement times were smaller than 250 msec. while activity in some movements was noted when durations were as high as 550 msec. At the shortest amplitude movement (13°), antagonist activity was seen in some records with movement times of 320 msec.,

but was consistently observed at duration shorter than 190 msec. Antagonist EMG appeared to be linked more closely to certain ranges of movement time rather than movement velocity because we noted many records without antagonist activity whose velocities were greater than records with antagonist EMG.

The beginning of antagonist activity with respect to the onset of movement appeared to be linearly related to movement time (correlation coefficient = .92). As movement time shortened, the beginning of antagonist EMG shifted closer to the beginning of movement. A similar shift was noted as a function of movement amplitude. The earliest antagonist onset times occurred at amplitudes of 13°. In a number of the quickest movements, antagonist activity preceded the start of movement by up to 40 msec. It was also noted that the time between the onset of antagonist EMG and the peak of movement is fairly constant across amplitudes and movement times. The mean value of this parameter for 212 movements was 118 msec. $\pm$ 36 msec. No clear relationship was found between antagonist burst duration and either movement time or velocity. Several patients with central nervous system damage were observed to have a disorganization in the synergy patterns relating to agonist and antagonist muscles. A disorder in timing of EMG activity was noted.

APPLICABILITY: The relationships between burst duration and movement time as well as the timing interactions between agonist and antagonist muscles likely reflects a central timing strategy. The burst pattern and its timing as well as the timing relationships of the antagonist muscle with regard to its onset and the onset of movement are likely specified by central programming. The literature has demonstrated the presence of burst patterns when people perform at maximal velocities. This study has demonstrated the presence of burst patterns at submaximal velocities and in particular has emphasized the relationship of the burst pattern to movement time rather than to absolute values of movement speed. The literature has also suggested that the antagonist burst might be considered a stretch reflex. In this study we observed antagonist activity at a time when stretch of the antagonist muscle did not seem to take place. This study gives more support to the concept that agonist and antagonist activity in rapid movements is more likely to be centrally programmed. The implications of our findings in normal subjects are that patients with central nervous system disorders should be studied in greater detail to establish the aberrant timing patterns and speed capabilities of these patients. In addition, the study would suggest that treatment strategies for central nervous system disorders where movement speed has been affected might conceivably be based on improving movement time.

132 Motor Unit Composition and Voluntary Force in Neuromuscular Disease

Principal Investigator:	A.W. Monster, Ph.D.	
Status:	Completed	
Dates:	November 1975-October 1977	
Cost:	Annual \$	Projected Total \$102,489
	RT Annual \$	RT % of Annual Total
Annual Report Reference:	#14, Page 68, R-144	

OBJECTIVES:

1. To measure motor unit composition in a representative number of patients with neuromuscular disease of varying intensity and known etiology.
2. To compare the diagnostic outcome of a number of existing and proposed (electro) myographic procedures.
3. To describe, in functional terms, the pathological changes resulting from the disease process, including compensatory changes.
4. To determine under what pathological conditions the normal organizational principles of motor unit activation and of voluntary force production, are either maintained or reestablished during recovery.

METHODOLOGY: The present methodology consists of three parts that are complementary to one another.

1. **Screening of Patients and Normal Individuals:** This consists of a general medical history, including neuromuscular status, ADL, voluntary motor coordination, sports activities, tremor, circulatory and metabolic disorders, routine use of drugs, emotional attitude, commonly perceived discomforts and general tolerance. The emphasis is placed on documenting the onset and time course of the neuromuscular disorder, severity of the disability as perceived by the patient, and the history of therapeutic trials, if any. A profile of each patient's residual motor power is documented on the basis of standardized tests.
2. **Motor Unit Composition:** The unit composition of a muscle is a measure of the force-producing potential of that muscle. Total number of units in the composition is quite stable over the normal adult age range. Our current methods of composition measurement are based on the highly systematic and mostly invariant way in which a muscle's motor unit pool is volitionally activated during a slowly increasing contraction. Due to this systematic motor response, observations on the behavior of a small representative number of units characterize the average behavior of units in a muscle's motor unit pool. These observations can thus be used to obtain composition estimates.
3. **Long-Term Studies on Muscle Usage:** The level of motor dysfunction of a muscle or muscle group in a patient with neuromuscular disease is directly related to the extent in which these muscles are required to produce force in order to perform normal functions. To evaluate this relative dependency, normal individuals and patients are instrumented with surface electrodes placed at one or more muscle groups. Muscle activity is recorded for long time periods. Computer analysis of this activity considers the average degree of usage and its relation to muscle fiber type, peak power requirements of different types of functions including appropriate vocational activity, synergy linkages among muscle groups, and changes in strength and endurance with physical exercise; especially limits to improvement and age-dependency of such limits. This data is correlated with the unit composition measurements.

FINDINGS TO DATE: During the first year, emphasis was placed on the following problems:

1. The ability of patients to tolerate the EMG motor unit composition procedure for a time period long enough to allow the examiner to sample a sufficient number of units. It was found that with a highly automated data logging method a total of 20 to 40 units could be sampled in less than one hour (10 patients). This number of units was sufficient for diagnostic purposes.
2. Recording of unit firing rates as a function of voluntary effort is relatively time-consuming. Knowledge of unit firing rate responses to changes in voluntary effort is required for obtaining a composition estimate. However, it was found that the number of units to be examined can be drastically reduced because of fairly consistent relationships that exist between a unit size and its firing behavior (based on a study of 180 simultaneously recorded unit pairs). Some sources of differential firing behavior are being examined further.
3. Unit size estimates based on EMG surface potentials are unreliable for large muscles. This is a result of the nonuniform distribution of the muscle fibers of specific units throughout the muscle cross-section. A prototype size-depth normalization method was developed for the tibialis anterior.
4. Recordings of normal usage patterns were made for 8 different muscles. A number of parameters characterizing usage have been developed as a normal data base.

During the second year emphasis was placed on: (1) clinically testing the present composition estimation method; and (2) comparing normal and abnormal usage patterns and their relationship to unit composition.

APPLICABILITY: Rehabilitation of voluntary functions depends on both adequate control of volition and on sufficient motor power. Whereas the problems of volition are complex and difficult to separate in identifiable component parts, the process of voluntary force production is definable in a functional-physiological sense. By diagnosing and describing the consequences of neuromuscular disease in functional terms, our understanding of the rehabilitation process is enhanced. The obtained findings lead to a clearer rationale for **therapy** in patients affected with these disorders. Significant **diagnostic** applications result from evaluative model of motor unit usage during voluntary muscle contraction.

133 Computer Characterization of Patient Services

Principal Investigator: E. Kwatny, Ph.D.
Status: Completed
Dates: November 1975-October 1978
Cost: Annual \$9,100 Projected Total \$27,300
RT Annual \$9,100 RT % of Annual Total 100%
Annual Report Reference: #15, Page 219, R-148

OBJECTIVES: In order to characterize and evaluate patient services leading to functional recovery, a system must be developed to manage the abundance of information related to patient status and performance. The objectives, then are:

1. To develop a clinically oriented system for the management of clinical research data.
2. To develop a means to construct an appropriate data base of clinical and laboratory data.
3. To evaluate and demonstrate the system using the research utilization service.

METHODOLOGY: The technical staff (computer and information science) involved with this project will interact with the clinical and clinical research teams to better define the data relationships between testing and measurement and the data requirements for each set of evaluative tests. These data will then be used to define the structure of the data base maintained for patients undergoing evaluation and care in the rehabilitation service.

This system is to be used, principally, to help evaluate and establish relationships between clinical and research data. To do this, data collected and processed as a result of testing in the laboratory must be available to the clinician through the data management system. An organized set of data filing structures is to be constructed for storage of all data collected in the laboratories. The file structures will be hierarchical with test data saved in the lowest or most basic level, and data that have resulted from analysis, saved in higher levels. Through the use of a common storage structure with patient and data identifiers, a generalized data management system can be developed to manipulate all laboratory data within the Center.

A data base management system will be defined based upon current methodologies in this technology and using information gained from clinically oriented data base systems developed elsewhere.

FINDINGS TO DATE:

1. **Systems developed elsewhere:** Literature survey of developed systems revealed that the differences in application and purpose have resulted in very little commonality among clinically oriented data base management systems, especially for compatible hardware systems. A great deal of useful information is available concerning the methodology of specifying and utilizing data relationships. This includes specification of parameters related to the description and quantification of functional performance.
2. **Data Base Requirements:** Conferences with clinical staff and research therapists were held to examine and define data types and structures from which the data base would be constructed. The base level of the hierarchically structured laboratory data base, the "experiment data file" was defined and incorporated into all laboratories within the Center. The clinical data base management system will interface to this data file as well as higher level analysis files. The design of the clinical data base structure can now proceed in parallel with the continuing development of the research data base.
3. **Relationship to the Multi-User Computer System:** An analysis was made of the difficulties resulting from the implementation of this system with a multi-user computer system that also supports laboratory activities and other data processing. A serious problem is the very limited on-line rapid-access data storage facility. Only portions of a large data base can be available at any one time with the present equipment. The addition of a magnetic tape storage facility has eliminated problems related to storage of stable, archival records. Data transactions to the mass storage

devices can excessively burden other data processing activities and laboratory data acquisition, because of the type of equipment available.

4. **Development of the Clinical Research Information Management System (CRIMS):** Although this system was designed around the specific requirements of the research utilization service, CRIMS' functionality is that of a generalized data management system. CRIMS is a set of computer programs and languages that acquire data, organize the data for storage, store and retrieve records, maintain data files, process user queries and other commands to the system, and transmit and display retrieved data. User commands are English acronyms, and CRIMS requires only that the user be familiar with the language of the data base management processor.
5. **Development of data structures for laboratory data:** A well-defined hierarchical laboratory data storage system has been designed with two levels of this hierarchical structure developed through this project. Both are currently in use. The lowest level data file contains the actual data collected during an experiment and all of the information necessary to describe the experiment and data. The second level data file is used to store the results of data processing; either parameter values or intermediate data to be further processed to yield parameter values. This second level data file contains parameter values that are to be extracted by the clinical data base management system for use by the clinician.

APPLICABILITY: In a program such as the Model Rehabilitation Service, as the number of tests and therapy programs is increased to include new concepts and procedures, vast amounts of data become available for analysis of patient function. This system would assist in providing a summarization of functional performance (and thus improvement). This would reflect on the relationship between therapy programs and the rate or level of recovery. Quantification of functional analysis is critical for objective evaluation of effectiveness and utilization of new rehabilitation concepts or procedures. This is true for evaluation procedures developed within and outside the Center.

The availability of all clinical data related to a particular patient assures the clinical research groups that they have all necessary information to evaluate the effects of other programs or therapy on the patients that they are treating. This is necessary to evaluate the efficacy and utility of a particular remediation program.

134 Assessment of Driving Capabilities of the Brain Injured Population

Principal Investigator:	W. Freedman, Ph.D.	
Status:	Completed	
Dates:	November 1976-August 1977	
Cost:	Annual \$16,065	Projected Total \$49,158
	RT Annual \$16,065	RT % of Annual Total 100%

OBJECTIVES: The following goals are designed to be accomplished in sequential order:

1. Development of state-of-the-art paper on assessment of driving capabilities of the brain-injured population.
2. Identification of "need" for research based on specific biological and behavioral requirements gotten from the literature survey and from on-site visits to existing driver-assessment facilities.
3. A research plan to develop a process for assessing the driving capabilities of brain-injured people.

METHODOLOGY: In order to achieve the objectives of this proposal an extensive literature search was made in order to compile the information available concerning the brain-injured population. This included physiological-functional information so as to specify those parameters present in the driving environment which could affect driving performances of the brain-injured. Identification of vehicle dynamics under various road conditions was necessary, as was knowledge of driving tasks.

Included in the search was a review of the state and federal guidelines to determine the assessment procedures currently in use. This also required a compilation of the procedures of medical review boards in the various states. The state-of-the-art literature review was augmented with personal visits to selected facilities which have demonstrated expertise in driving simulation.

psychological testing for driving capability, on-road instrumented assessment and treatment of brain-injured patients.

The population which this study consisted of were people who must contend with dysfunctions resulting from brain injury. Individuals exhibiting sequelae of the following etiologies were included: congenital lesions (e.g., cerebral palsy); acquired lesions (e.g., tumor, stroke); and degenerative lesions (e.g., cerebellar atrophy).

From an integration of the state-of-the-art with biological-functional information, a plan for further research will be recommended to develop a method to assess the driving capabilities of patients and to develop the interface between diagnosis of medical disability and assessment of functional performance in the tasks of driving.

FINDINGS TO DATE: This study report is the beginning of a solution to the problem of assessing driving capabilities of the brain-injured population. The results were intended to provide a basis on which future studies could be built; it will be seen, however, that there is almost no information available in the literature. The relevant citations and ancillary materials which were found are listed and a suggested research program has been developed and submitted to the Veterans Administration. Compilation and summarization of literature were accomplished by computer and hand searches of all recently published material. The computer searches of data bases were completed using key word lists and expansion techniques. Primary sources which were searched are listed in Table 1 with the years of coverage.

Table 1
Literature Sources Searched

Source	Period Covered
Medline (Index Medicus)	1965 - present
National Technical Information Service	1964 - present
Transportation Research Information Service	1965 - present
Science Citation Index	1974 - present
Psychological Abstracts	1967 - present
Social Scisearch	1972 - present
Compendex	1970 - present

The literature search was conducted in response to the following requirements:

1. A search to acquire all literature pertaining to assessment of automobile driving capability of brain-injured people. The term "brain-injured" here implies chronic disorders of the neurological system resulting from natural or traumatic causes.
2. Investigation of the existing methods of driver education and training used to assist this target population to become capable of operating an automobile.
3. Acquisition of information from medico-legal documents and licensing procedures presently used to determine driving capability of the target population. Included in this study's "brain-injured" population are those with cerebral palsy, cerebellar disease, head injuries, strokes or cerebrovascular accidents, and tumors of the brain. The population does not include amyotrophic lateral sclerosis (ALS), epilepsy, mental retardation (unrelated), spina bifida, spinal cord injury, and sensory deficits (i.e., hearing or visual impairments).
4. Identification of population size of "brain-injured" people who are licensed to drive automobiles or of those who wish to drive.

Based on title, author, source, or reason cited, efforts were made to obtain full copies of materials and to determine their relevance. A bibliographic listing of all pertinent material is listed in the next section.

National prevalence information concerning the target population was obtained from government estimates. While data found in Table 2 suggest the size of specific categories of disorders of the target population of "brain-injured," the estimates of the number of afflicted persons who drive is almost non-existent. It should be stated that neither the Veterans Administration nor the National Highway Safety Administration of the Department of Transportation could provide any

estimates of the size of the driver population of the specific target disorders.

Table 2
Estimates of the United States Afflicted Populations with
Target Group Neurological Disorders Operating Automobiles

Disorder	No. of Afflicted Persons	No. of Afflicted Persons Driving
Cerebral Palsy	750,000 (6)	-
Cerebellar Disease	-	-
Head Injuries	3,000,000 (6)	-
Strokes (cerebrovascular accidents)	2,500,000 (6)	10,000 (1)
Brain Tumors	32,000 (6)	-

The relevant bibliography and discussion of a research plan are presented in the Annual Progress Report #4.

APPLICABILITY: It is clear that those brain-injured who are able should be provided the opportunity to operate a licensed vehicle. The questions are: how and who shall determine their driving capability? This project will attempt to suggest answers to these questions.

In addition to the independence and self-respect which is provided by mobility for the disabled, it also opens up the opportunity of self-support for the individual which benefits the individual and the taxpayer.

135 Visual System Disorders and Functional Correlates

Principal investigator: E. Kwatny, Ph.D.
Status: Continuing
Dates: November 1976-October 1979
Cost: Annual \$29,293 Projected Total \$101,465
RT Annual \$29,293 RT % of Annual Total 100%
Annual Report Reference: #15, Page 18, R-143

OBJECTIVES: The purpose of this project is to provide quantitative clinical-physiological-functional analysis of certain visual system disorders that interfere with the delivery of sufficient visual information to the central nervous system. Specifically, the objectives are threefold:

1. To establish a sequence of tests to evaluate quantitatively the status of central and peripheral mechanisms participating in the control of ocular movements. This includes the objective measurement of the function of the supranuclear control systems which integrate visual and non-visual stimuli to position the eyes so that basic and skilled functional activities may be accomplished.
2. To evaluate quantitatively functional activities such as visuo-motor skills, visual perception, and reading to determine the influence of visual system disorders on dysfunction.
3. To investigate new therapeutic approaches to modify visual behavior so that it is more appropriate to functional activities.

METHODOLOGY: Population: normal adult subjects (18-75 years of age); hemiplegic adults (18-75 years of age); adults with neurological disease with manifestation of ocular dysfunction (18-75 years of age).

Test Procedure: (a) medical screening—a general medical history statement is taken from each subject with concentration on questions dealing with vision history, visuo-motor performance, ADL performance, and neuro-muscular status. Site of lesion, functional loss, current therapeutic program and visual system impairment is acquired from clinical notes and therapists. (b) Clinical optometric examination—this examination includes ophthalmoscopy, analysis of near and far acuity and visual field analysis (central and peripheral), and an external examination (detection of phorias and tropias, motor field and motility examination, vergence and stereopsis testing).

(c) Visual system mechanisms—eye and head movements are examined during a monocular and binocular viewing of a single spot stimulus in a 60 degree field. In order to evaluate the specific supra nuclear eye movement control systems, sequences of tests including several fixation, smooth pursuit and saccade generating tasks, are utilized.

Visual perceptual and visuo-motor examinations: in order to examine functional visuo-motor activities of a subject, visuo-motor and visual perceptual tests are applied to assess whether a subject's visuo-motor activities are limited, and whether the source of these limitations are visual and/or motor. Visuo-motor activity is tested using an array of 25 lamps which are randomly lighted and are extinguished by having the subject touch the lighted position. Time of movement initiation and response and accuracy of response in acquiring the lighted stimulus are measured. Background illumination is varied (subdued lighting and total darkness) to permit examination of influences of visual and kinesthetic feedback on motor control. Visual perception, including form perception, form constancy, spatial relationships, visual memory and visual discrimination is examined using the Motor-Free Visual Perception Test. This test has been expanded to include the figures spatially reordered to the opposite side of the midline to evaluate visual neglect. An analysis of visual behavior during this test is accomplished by measuring horizontal and vertical eye movements during administration of the test.

Therapeutic Programs and Team Conferences: Team conferences have been implemented to discuss visual system dysfunction among all of the staff involved in testing of the patient. The objectives of these meetings are: (a) to integrate the results of all evaluations and relate the results to the patient's functional losses; (b) to determine needs for additional testing; (c) to define treatment objectives and course of treatment for the patient. Prescriptive therapy is carried out by either members of the project staff or the patient's regular therapy staff. Therapists are trained to administer treatment programs that are unfamiliar to them. In order to determine effectiveness of treatment, pre- and post-treatment evaluations are carried out.

FINDINGS TO DATE:

1. Visual Perceptual Performance: The regular and "reversed" format of the Motor Free Visual Perceptual Test (MFVP) has been administered to 30 normal subjects. Time to respond for each item were also measured. The data indicate: (a) average scores are the same using the standard and "reversed" formats; (b) the composite score (right and left space) slightly increases the perceptual score. The increase is greater for subjects with low scores on both the standard and the "reversed" tests; (c) the average score and response time increase slightly with age; (d) the normal subjects respond equally well to the same figures whether they are right or left of midline. Forty-six patients have been given the regular and "reversed" format of the MFVPT. Patients scored lower and responded more slowly than age-related normals. Unilateral visual neglect is separated as a confounding issue by a preponderance of responses to one side when both formats are used. Pure perceptual deficit is identified by the variation in raw scores.
2. Visuo-Motor Coordination: In addition to total time for target acquisition and accuracy of response, time of initiation of hand movement is now measured during use of the visuo-motor test board. Twenty-six normal subjects have been tested with dominant and non-dominant limbs and the three measured parameters are not significantly affected by age or limb used. Thus, it is assumed that patient responses would not be influenced by use of a non-dominant limb. Reliability of testing has been examined in an additional normal population of 17 subjects. Forty-five brain-injured patients have been tested and they require nearly twice as long to reach the stimuli than normals (whether they have visual feedback of the limb movement or not). The data suggest that time of response is greater for patients in all test conditions, and the no visual feedback condition stresses the functional performance to better separate the two populations. It can be inferred from the data that these patients rely more heavily on using their vision to guide their motor performance and that in this group motor control is sub-normal. The visuo-motor test board has also been used to evaluate response to treatment and to better define therapeutic strategies.
3. Visual System Mechanisms: Patients with hemianopsia who exhibit functional visual neglect or do not have the awareness of their field loss were found not to respond to an instantaneous change of position of a spot stimulus into their blind field. There was no initiation of a search pattern of any kind. Other patients that have become aware of their restricted field will initiate a search for the stimulus. A characteristic searching movement is seen in this patient's small amplitude, small intersaccadic intervals. Several hemianopic patients have been observed with smooth pursuit

eye movements in the presence of a moving reference but at a velocity different from that of the reference (the physiological basis for this is unknown). Compensation for visual field loss is a necessary precursor to the acquisition of functional activities following cerebral insult. Various types of compensatory eye movements in hemianopsia have been observed. A patient with a diagnosed exclusive cerebellar lesion was examined. Oculomotor abnormalities of smooth pursuit and increased vestibulo-ocular excitability were observed in confirmation of the diagnosis.

4. Evaluation of Oculomotor Activity During a Perceptual Task: In order to define normative performance, 10 non-brain-injured subjects were tested with the MFVPT while eye movements were monitored. The data reveal a great variability in individual performance, not only among subjects, but also with the same subject performing different tests. The particular sequence of eye fixations in the perceptual task appears to be an indicator of the procedure involved in information processing. These preliminary data indicate that there is a similarity in the sequence of the first three eye fixations. Variability after the third fixation may be due to past visual experience, type of visual task required, etc. Five brain-injured patients have been tested. The performance of the individual patients was as variable as the normal sample. The fixation sequences differed (even in the first three fixations) than the normal group.
5. Visual Function Symptomatology: In order to demonstrate the utility of the new assessment procedures in determining a more appropriate therapeutic program for a patient, it is necessary to document the symptomatology for each diagnostic category, as defined by each of the assessment procedures. It is desirable to develop a method of documentation from which one could describe or correlate functional loss, diagnostic category and the results of any of the visual assessment procedures. Further, this documentation should be useful in treatment planning on the basis of results of visual system assessment. Symptomatology has been developed to describe the results of each of the procedures.
6. Treatment of Visual System Function: Eight patients were given specialized attention to their visual problems based on results of the assessment procedures. Functional goals were set for each patient and objective pre- and post-therapy tests were given to measure the functional level. For the eight patients, a total of ten goals were set, five were achieved, two were partially achieved, two were not measurable, and one goal was not achieved.

136 Ambulatory Monitoring Laboratory for Rehabilitation Medicine

Principal Investigator:	A.W. Monster, Ph.D.	
Status:	Continuing	
Dates:	November 1977-October 1979	
Cost:	Annual \$53,356 RT Annual \$25,794	Projected Total \$119,700 RT % of Annual Total 48%
Annual Report Reference:	#15, Page 38, R-152	

OBJECTIVES:

1. To demonstrate the routine clinical use of ambulatory monitors for a number of well defined assessment problems, (e.g., relation between physical activity and cardiac symptoms as observed in EKG).
2. To test the utility of a number of ambulatory transducer systems, recording systems, and analysis methods for a second (less well-defined) group of assessment problems (e.g., the description of the obligatory synergy response in stroke patients).
3. To develop a prototype ambulatory monitoring laboratory, organized as an evaluation service, for both inpatients and outpatients.

METHODOLOGY: The patient carries a miniature multi-(2-4) channel tape recorder on a waist belt. Commercially available recorder (Avionics, Medilog) are approximately the size of a desk calendar and weigh one to one and one half pounds. The recorder is connected to one or more transducers (e.g., electrodes, accelerometers, etc.) through signal conditioners placed within the recorder unit. The transducers monitor physiological variables such as muscular activity, the electrocardiogram, and biomechanical parameters. Interference with normal functional

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activities is minimal. Typically, a recording is continued for 8-24 hours, after which the tape is removed. The tape is then played back, on a separate tape scanner, at 25 to 60 times the recording speed. The computed data analysis is printed out on a high speed printer, using a standardized format. By maintaining a record of successive recording on one patient, as well as a library of normal reference data, comparative evaluations can be made.

FINDINGS TO DATE: The following was accomplished during the first year.

1. A diagnostic ECG scanner was developed for arrhythmia detection in 24 hour ECG tapes. A cooperative project was undertaken with Albert Einstein Medical Center Cardiology Department for patient referral and evaluation. The highly automated scanner can complete data reduction of 24 hour tapes of moderate arrhythmia activity in less than one hour. Results were presented at the Conference on "Computers in Cardiology," September 1978.
2. Muscle activity patterns were studied in a number of functionally-linked muscle pairs in 12 normal males. A number of EMG parameters correlated significantly with muscle fiber type distribution. The average duration of contraction was directly related to the percent of Type I fibers (Science, Vol. 200, 21-314-317, 1978).
3. A scanning system was developed for evaluation of biofeedback therapy for postural stability training of cerebral palsy children. Data from 6 patients have been analyzed. The data have provided encouragement that ambulatory monitoring may place this type of long-term therapy on a more scientific evaluation basis.
4. A number of studies were undertaken to evaluate the utility of blood-oxygen transducers for ambulatory purposes. Different compromises will be examined in a follow-up study on a group of pulmonary rehabilitation clients.
5. Results from several of the above studies are being used in the development of a more general 4-channel cardiopulmonary scanning system to be used as an ambulatory monitoring prototype.

APPLICABILITY: The ultimate goal of the rehabilitation process is to enable patients to perform at their highest attainable functional level. However, present evaluation methods rarely aim to establish whether this goal is reached during every day activities under diverse environmental conditions. Ambulatory monitoring provides a new and potentially powerful approach to problems of patient-status evaluation. This approach is highly cost-effective, as it is directed toward out-patients and non-hospitalization. New methods require effective and convincing demonstration before they can be integrated within the routine repertoire of clinical evaluation methods. This project is designed to demonstrate the contributions that an ambulatory monitoring laboratory can make to the rehabilitation process.

137 Facilitation of Arm Movement in Patients with Stroke, Brain Injuries and Other Pathologies of the Central Nervous System

Principal Investigator:	N. Mayer, M.D.	
Status:	New	
Dates:	November 1978-October 1981	
Cost:	Annual \$68,892 RT Annual \$60,134	Project-1 Total \$240,341 RT % of Annual Total 87%
Annual Report Reference:	#15, Page 78, R-158	

OBJECTIVES:

1. To test the effect of sensorimotor facilitation on behavioral parameters of voluntary movement such as initiation (latency responses), movement time, maximum velocity, and termination accuracy of movement.
2. To modify and augment existing electrical stimulation systems which are to be employed in facilitation of voluntary movement.
3. To test the effect of sensorimotor facilitation on electromyographic features of voluntary movement such as EMG reaction time, latency between initiation of EMG and initiation of mechanical

displacement, burst or continuous pattern of firing, distribution of the integrated EMG over the movement interval, and temporal relationships between agonist and antagonist muscles.

4. To conceptualize a clinical training program which might utilize sensorimotor facilitation techniques based on the use of electrical stimulation applied in temporal relation to volitional movement.
5. To conceptualize clinical instrumentation which could deliver sensorimotor facilitation and would provide measures of outcome during the training period for purposes of objective clinical evaluation.

METHODOLOGY: A considerable body of opinion favors the use of facilitation techniques as part of the retraining program for patients with upper extremity movement difficulties secondary to central nervous system lesions. Clinical techniques place emphasis on therapist generated non-specifically timed sensory stimulation. The suggestion has been advanced that background excitability preceding voluntary movement is impaired in upper motor neuron lesions. The rationale of this project is based on the idea that sensory stimulation delivered electrically **prior to and in timed relation to** a specific voluntary movement can result in facilitation of certain features of movement, such as initiation, speed, and range in patients with cortico-spinal system lesions. A two factor mixed analysis of variance design with repeated measures on one factor will be carried out. Three conditions of stimulation and three separate testing sessions will be considered as independent variables. The conditions of stimulation include: (1) no stimulation; (2) stimulation before movement; and (3) stimulation during movement. Behavioral and electromyographic measures will include mechanical latency (reaction time), movement time, maximum velocity, agonist EMG and the time of onset of EMG with respect to the time of movement initiation. The project seeks to explore the clinical concept of facilitation in a systematic manner in patients with movement control disorders.

APPLICABILITY: The problems of the movement disabled patient are particularly relevant since there are large numbers of patients disabled by central nervous system disorders such as stroke (3 million cases), multiple sclerosis (250,000), spinal cord injury patients (100,000), and traumatic brain injuries (400,000). Information gained in this project would be directly utilized by kinesiologists, clinicians, biomedical engineers working with functional electrical stimulation systems, and therapists, and would be especially useful in the training of residents in orthopedics, physical medicine and rehabilitation and neurology.



**George Washington University (RT-9)
Medical Rehabilitation Research and Training Center**

CORE AREA

**Psychosocial, Vocational and Performance Capability Studies
in Severe Disabilities**

The rehabilitation outcome of the severely disabled which is dependent on the interrelated areas of psychosocial, vocational and performance capability factors.

THE GEORGE WASHINGTON UNIVERSITY

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COMPLETED

ABSTRACT NO.

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138 Vocational Potential of ESRD Patients through Analysis of the Relationships between the Medical Factors of ESRD and Alternative Job Placement Strategies

Principal Investigators: Alvin E. Parrish, M.D.
Norman C. Kramer, M.D.
Wu S. Chiu, M.D.
Kallsankar Mallik, M.S., M. Tech.

Status: Completed

Dates: December 1976-February 1979

Cost: Annual \$84,950 Projected Total \$140,000
RT Annual \$61,988 RT % of Annual Total 73%

Annual Report Reference: #14, Page 207, SR-9

OBJECTIVES: This project proposes to accomplish the following objectives:

1. To develop an understanding between:
The primary disease producing End-Stage Renal Disease.
Medical complications associated with hemodialysis.
Work tolerance of patients undergoing chronic hemodialysis.
Impact of dialyzing schedules and vocational potential.
2. To produce, based on the findings in Objective 1, a protocol for assessing vocational potentials of ESRD clients including strategies for:
Restructuring clinical procedures and dialyzing schedules to minimize negative vocational impacts.
Job restructuring and modification to accommodate reduced work tolerance and dialysis scheduling problems.
Job retraining into vocational fields most suited to the ESRD client population.
3. To conduct a region-wide conference to disseminate project findings to vocational rehabilitation counselors and ESRD clinical personnel.

METHODOLOGY: A group of clients with End-Stage Renal Disease will be studied so that factors such as medical complications (type and frequency) and physiological performance capability can be examined in relation to type of work experiences, loss of time from work, setting of dialysis, family support and complicating disease.

In the assessment of performance capability, nerve conduction time in the leg will be measured using a model TEC 6M electromyograph and exercise testing will be used consisting of 10 minute walking at 2.5 miles per hour at no grade to determine the ability of the client to exert minimal activity. Concomitantly, changes in serum potassium, lactate pyruvate, blood pH, blood pressure and respiratory rate will be monitored.

Areas in which vocational project staff will concentrate are:

1. Selection of realistic vocational objectives according to physical and cognitive functions;
2. Development of short term training programs commensurate with actual employment opportunities;
3. Initiation of group sessions for clients and family members to promote work motivation;
4. Work site environment modification;
5. Job restructuring; and
6. Treatment regimens and dialysis schedules.

FINDINGS TO DATE: Medical and Performance Capability Assessment. A survey was begun in December 1976, of patients at the Dupont Circle Dialysis Center, relating to their dialysis complications and ability to return to work. Beginning in July 1977, physical studies were begun using the exercise

test to determine patient's ability to exercise for a standard period of time. The selection of patients was made at Dupont Circle Dialysis Unit, using those individuals who physically appeared capable of undergoing the exercise test and who volunteered to take part. The procedure was as follows: on the morning prior to dialysis the patient had baseline determinations of blood pressure, pulse, respiration, lactic acid, lactate pyruvate, potassium and blood pH. Each individual was then exercised on a treadmill, walking for 10 minutes at 2.5 miles per hour at no grade. At the end of the exercise, the baseline tests were repeated again, in 10 and 20 minutes, post exercise. To date, six normal individuals and seven patients with End-Stage Renal Disease have been studied. The maximum change in the values observed are shown in Table 1. The most significant changes occurred in serum lactate levels and in this group of studies, 4 out of 7 patients with End-Stage Renal Disease, showed a maximum increase in serum lactate exceeding two times the standard deviation of normal individuals. In all four of these individuals symptoms developed during the test which in two, precluded the completion of ten minutes of exercise. Symptoms consisted of weakness and fatigue in the legs. These individuals also showed an increase in potassium and in one individual, a decrease in blood pH.

It would appear from these preliminary findings that individuals undergoing maintenance hemodialysis do have physical disabilities as manifested by their inability to exercise at a minimal rate, and that this inability may be related to their failure to return to an active life. Two possibilities as to the cause may be postulated: (a) that there is inadequate dialysis, resulting in abnormal carbohydrate metabolism, since it is already known that individuals with renal failure develop carbohydrate intolerance with elevations in serum and blood sugars and abnormal glucose tolerance tests, and since it has been shown in animals that this appears to be a block in either cyclic AMP or ATP. It is possible that an inability to develop aerobic metabolism in the Krebs' cycle could account for the rise in serum lactate; and (2) that these individuals are physically in such poor condition that they are unable to carry out the exercises. It is proposed, therefore, that when sufficient data is obtained, that two additional groups will be studied, made up of those individuals who show an increase in serum lactate greater than twice the standard deviation of normal in individuals. One of these groups will have increased dialysis time; the other group will undergo standard exercises to increase their physical fitness. After a period of time (4-6 weeks) the tests will be repeated to see if improvement in the testing occurs.

Vocational Aspects: A comparison study of working versus non-working ESRD clients conducted during the first year of the study enabled project staff to identify factors which tend to inhibit vocational success of ESRD clients. Most significant were such factors as client level of experienced fatigue, presence and frequency of secondary medical complications, lack of early vocational planning, lack of training in appropriate job skills and financial disincentives to return to work.

Based on the analysis of first year data, the following hypotheses were formulated for continued study in the second year:

1. Vocational counseling and career guidance during pre-dialysis and early dialysis will increase vocational outcome;
2. Skilled ESRD clients are more likely to remain employed and/or find employment than non-skilled clients;
3. A bio-engineering approach will increase the range and kind of jobs possible for ESRD clients by reducing physical exertion inherent in many job tasks;
4. Financial disadvantages create barriers to employment of the ESRD client.

During the second year's activities, project staff began, developed and implemented vocational programs for unemployed ESRD clients. Out of 14 clients referred, staff assisted six clients to return to part-time employment (five working on-site and one working homebased). Vocational strategies used by staff in an attempt to reduce vocational barriers to ESRD clients included: provision of early vocational counseling; vocational skill training; application of low cost aids to reduce fatigue experienced in performing job tasks; job restructuring; homebased employment to reduce transportation and fatigue problems; and vocational and medical follow-along services.

The results of staff activity in the first and second years indicate that provisions of such services as listed above can result in improved vocational potential of ESRD clients. Although a limited client population and insufficient time to study long term effects of the services provided prevent total

substantiation of the four hypotheses, the partial results are supportive. Of the six unemployed clients placed in the second year, five were able to begin work after provision of appropriate skill training and one was placed using existing skills. A follow-up on nine working clients who participated in the first year comparison study revealed that of the five skilled workers, three are still working, one has retired, and one is deceased. Of the four unskilled workers, only one has maintained employment and three are no longer employed. This result is supportive of hypothesis #1. As vocational counseling and career guidance services were not initiated until the latter part of the study, no conclusions on hypothesis #2 can be drawn at present.

The results of the application of low cost engineering technology for two clients working in the micrographics industry is supportive of hypothesis #3. Employment barriers caused by financial disincentives (hypothesis #4) were significant in preventing four of the six placed ESRD clients from considering full-time employment.

The findings also suggest that in spite of vocational services, the individual response of ESRD clients to dialysis does place limits on the client's potential work capacity. The project findings indicate, however, that these limits may be measurable.

The project staff has therefore submitted a new proposal to develop a system for assessing the ESRD client's potential work capacity and pinpointing problem areas for development of appropriate intervention strategies. The developed system should also provide a means for measuring the effectiveness of intervention in reducing barriers to vocational rehabilitation. Once developed, such a system should aid the rehabilitation professional greatly in providing appropriate services to the ESRD client population.

APPLICABILITY: It is anticipated that the results of this project will impact the vocational rehabilitation counselors' management and, potentially, could suggest clinical management alternatives.

139 Role of Family in Institutional Rehabilitation of Clients with Behavioral and Physical Disabilities

Principal Investigator:	David Reiss, M.D.	
Status:	Completed	
Dates:	July 1974-August 1979	
Cost:	Annual \$100,835 RT Annual \$71,396	Projected Total \$400,000 RT % of Annual Total 71%
Annual Report Reference:	#14, Page 42, R-45	

OBJECTIVES: The **behavioral disability** phase seeks to predict rehabilitation outcome of patients with chronic behavioral disability based on characteristics of their families; the **physical disability** phase seeks to make similar predictions for patients with spinal cord injury and stroke.

METHODOLOGY:

1. The behavioral disability phase will use adolescent and young adults (A). The psychiatric patients who lived at home with both parents until hospitalization. All patients will have been admitted to an in-patient psychiatric service for the treatment and rehabilitation of alcohol, drug abuse and delinquency problems. Both parents will be included in the study. Some phases of the study require the professional staff and some administrators in the sponsoring institutions to serve as subjects. The physical disability phase will use end stage renal disease patients. All 30 patients will have lived in intact families before being hospitalized.
2. Family, institutional and treatment processes, and outcome variables will be measured. Included in the variables will be the family's typical orientation to its social environment. Standardized interviews, symptom checklists, questionnaires and nurses' ratings will be used.

FINDINGS TO DATE:

1. In the behavioral disability phase, findings from 36 families show that laboratory assessment procedures permit families to be grouped into four categories based on the family's orientation towards novel and problematic social situations. This classification accurately predicts many

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aspects of the family's involvement in the treatment program; the degree to which the family is noticed by staff and other families, the extent to which the family can open itself to new advice and experience (rather than remain closed and self-protective) and the family's morale and sense of optimism about the treatment program.

2. The physical disability phase is well underway but no clear findings are available.

APPLICABILITY: Results of these studies should help rehabilitation staff to identify problem families within the first week or two of work with patients and their families. In particular, it should help to predict families who will undermine the treatment, simply fall from full attention or drop out of the program prematurely.

140 Post Coronary Group/Exercise Therapy Study

Principal Investigators:	Patrick A. Gorman, M.D. Melvin J. Stern, M.D.
Status:	Continuing
Dates:	May 1977-February 1981
Cost:	Annual \$103,995 RT Annual \$73,364
	Projected Total \$350,000 RT % of Annual Total 71%
Annual Report Reference:	#14, Page 58, R-48

OBJECTIVES: This project will compare the effectiveness of two separate treatment approaches, exercise therapy and group counseling, with each other and with a control group, in rehabilitating psychologically and/or physically disabled post myocardial infarction subjects. The object is to document changes in various vocational, psychological, physical, and social parameters following a twelve week intervention program and throughout a one year follow-up period.

The following outcome variables are examined in the three experimental groups to determine the rehabilitative effects:

1. **Vocational** - Return to gainful employment, number of hours employed, job related responsibility, income.
2. **Psychological** - Change in depression/anxiety scores; increase in 'positive' factors, i.e., 'carefree' on adjective check list.
3. **Physical** - Change in physical work capacity, heart rate and blood pressure responses and exercise induced arrhythmias and ST changes.
4. **Social** - Increased social, familial and recreational functioning; return to active sexual functioning.
5. **Morbidity** - Particularly, readmission to the hospital and/or occurrence of cardiovascular events.
6. **Mortality**

METHODOLOGY: One hundred and fifty patients will be admitted to the study over a 3 year period. The primary source of recruitment is The George Washington University Medical Center Coronary Care Unit. This is an eight bed unit which had 408 admissions in 1974, 474 in 1975 and 587 in 1976. The number of documented myocardial infarctions has been approximately one-third of all admissions (approximately 200 patients based on the 1976 census). We estimate that of this number, 20-25% (40-50 patients) will be eligible candidates for the study. We expect to access between 25-35 of these patients into the study each year. The remainder of the annual quota of 50 patients will be recruited outside the hospital through contact with internists and cardiologists who regularly refer patients to The George Washington University Medical Center Exercise Laboratory. Announcement of the program's existence will be sent to area medical societies and heart associations and the the community at large via public service announcements in newspapers, radio and television.

The primary steps will consist of:

1. Screening of hospital records.
2. Initial physical evaluation.

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3. Psychological evaluation.
4. Randomization.
5. Rehabilitation programs:
 - a. group counseling
 - b. exercise training program
6. Follow-up evaluations.

FINDINGS TO DATE: Recruitment of participants for the project was started on 8/1/77. An outline of the Patient Flow Diagram (Appendix, Figure 1) and a request for patient referral was prepared and sent to attending physicians who regularly admit patients to The George Washington University Hospital and those who refer patients to the Exercise Laboratory. This outline was also sent to the local Medical Societies, Heart Associations and to the Heads of Cardiology in the area hospitals. With the collaboration of the Public Relations Department an advertising release was prepared for publication in local newspapers and for public service announcements on radio and T.V. The staff of the Coronary Care Unit and Progressive Coronary Care Unit was given detailed orientation about the project in order to secure their cooperation in the recruitment process.

The project staff make regular chart rounds and identify those patients who fulfill the criteria for eligibility. When a patient appears to be eligible, the personal physician is contacted to secure approval for possible participation and the patient is briefly contacted and oriented, and requested to attend a screening session at least 6 weeks from the time of the acute myocardial infarction.

In the first two years of the study, starting August 1977 through July 1979, 65 patients have been admitted to the study. Twenty-nine patients were allocated to group counseling, 18 to exercise and 18 to control. Of the total, 41 or 63% qualified for the study on the basis of low exercise tolerance, the remainder on the basis of anxiety/depression.

By July 31, 1979, 32 patients had completed their one year follow-up evaluation. There were 4 drop outs, 2 from group counseling, and 1 each from exercise and control.

Results were analyzed according to clinical cardiovascular events, work status, exercise tolerance, anxiety/depression, sexual activity. The exercise patients had fewest new cardiovascular events, highest return to work, a significant increase in exercise tolerance, and reduced levels of anxiety/depression. The counseling group showed the greatest reduction in depression and increase in sexual activity. The control group had the highest number of drop outs from work, and the highest levels of anxiety and depression.

It is emphasized that the above sample is approximately one third of the total population to be studied.

APPLICABILITY: Too early in the study to make definitive conclusions although above results suggest the interventions promote rehabilitation.

141 Identification of Communication Deficits in Patients with Right Cerebral Hemisphere Damage

Principal Investigator:	Penelope S. Myers, M.A., C.C.C.	
Status:	Continuing	
Dates:	May 1977-February 1981	
Cost:	Annual \$37,501 RT Annual \$26,696	Projected Total \$125,000 RT % of Annual Total 71%
Annual Report Reference:	#14, Page 77, R-49	

OBJECTIVES:

1. Identify the specific communication deficits in patients with right cerebral hemisphere damage and develop a framework for the analysis of these deficits which will facilitate diagnosis and rehabilitation.

2. Develop a test protocol to assess the communicative deficits in patients with right cerebral hemisphere damage by: (1) examining the available standardized tests for specificity and sensitivity; and (2) developing tests for those areas where standardized test fail to pinpoint deficits.
3. Develop guidelines to improve professional and family understanding of the communication deficits in patients with right hemisphere damage.
4. Hold training sessions with rehabilitation team members at GWU Medical Center as a means of improving their ability to communicate with right brain-damaged patients.
5. Counsel families of patients with right cerebral brain damage as a means of improving their ability to communicate with the patient.

METHODOLOGY:

1. Identification of Target Population and Initial Data Collection

A. Target population

- (1) Sex: male and female; Age: 18-75 years
- (2) Handedness: right
- (3) Medical history: recent onset of right sided cortical lesions with no past history of neurological disease

B. Initial Data Collection

- (1) Case History
- (2) All the basic clinical variables for identification of site and size of lesion including all the clinical signs and symptoms reputed to have diagnostic significance
- (3) Results of routine tests using computerized axial tomography
- (4) Interview with family and/or social worker
- (5) Obtain results of standardized testing from speech, occupational and physical therapies

2. Identification of Communication Deficits

A. Interviews with: patient, family, rehabilitation team members

- (1) Goal: to ascertain communication problems evident in social interaction and changes noted by family post onset
- (2) Develop standard questionnaire to replace interview

B. Development of Test Battery

- (1) Goal: development of a test battery sensitive to the specific disorders under investigation
- (2) Rationale: failure of standardized neuropsychological and language tests to identify communication disorders in the minor hemisphere
- (3) Areas of test development
 - a. Cognitive: verbal and non-verbal
 - b. Affect (emotionally conveyed responses)
- (4) Administration of tests to target population and age matched non-neurologically impaired controls
- (5) Analysis of results and modifications of tests as needed

3. On the Basis of the Data Obtained

- A. Develop a framework for analysis of right hemisphere communication deficits
- B. Develop printed guidelines to improve professional understanding of these deficits
- C. Lay the ground work for developing a standardized test battery

FINDINGS TO DATE:

1. Initial test protocol, designed to provide extensive speech samples under a variety of conditions, was developed. It included:
 - A. **The Boston Diagnostic Aphasia Examination** (Goodglass and Kaplan, 1976)
 - B. **The Hooper Visual Organization Test** (E. Hooper, 1958)
 - C. A story telling test using 10 TAT pictures as test stimuli
 - D. A 50 question interview conducted with the patient
 - E. A 50 question interview conducted with a family member
2. Administration of the above test battery to 25 right hemisphere patients made it clear that:
 - A. Right hemisphere patients do not have aphasia, but are communicatively impaired compared to normal controls in some areas:
 - B. The expressive speech of communicatively impaired right hemisphere patients suggests a deficit in:
 - (1) synthesis and integration of external information on a perceptual and cognitive level
 - (2) channelling and directing internal information
3. Development of a final test protocol based on results of initial test protocol to include:
 - A. **The Boston Diagnostic Aphasia Examination** (Goodglass and Kaplan, 1976)
 - B. **The Hooper Visual Organization Test** (E. Hooper, 1958)
 - C. A series of 10 open-ended, topic specific questions (to replace interviews)
 - D. A series of 5 picture descriptions

APPLICABILITY: The focus of this project is the identification of communication disorders involving: affect; visual imagery and internal image making; comprehension of connotative (versus denotative) language; shifts in cognitive style in which synthesis and integration of contextual cues has been sacrificed; increase in rigidity; and confabulation—none of which could be labeled aphasia and all of which impair communicative ability. The result of the study should expand the traditional diagnostic and rehabilitation services to include additional objectives for the remediation of the identified deficits. Family support programs would also be expanded to include counseling and strategies for dealing with the communicative disorders in right brain damaged patients. With improved understanding of the nature of the communication problems in the right hemisphere patient, a more realistic vocational rehabilitation plan could be made.

142 Human Engineering Factors Related to Disabilities: Use in Vocational Rehabilitation

Principal Investigators:	Kallsankar Mallik, M.S., M. Tech. James L. Mueller, B.I.D.
Status:	Continuing
Dates:	March 1978-February 1984
Cost:	Annual \$46,648 RT Annual \$33,250
	Projected Total \$335,000 RT % of Annual Total 71%
Annual Report Reference:	#14, Page 105, R-50

OBJECTIVES:

The Problem: Through Job Development Laboratory experiences with severe disabilities, some major barriers to vocational rehabilitation for disabled persons have been revealed:

1. Rehabilitation counselors are unable to visualize possible worksite modifications which could make employment possible for functionally limited clients;

2. Employers are resistant to hiring disabled workers due to a fear of cost and complexity of environmental modifications;
3. Manufacturers of products (which must be modified for disabled users) are ignorant of the human factors of disabilities which could help in designing products needing few, if any, modifications.

Information to fill these needs is sparse and extremely difficult to access. Consequently, many counselors and employers do not want to place the severely disabled person. Manufacturers continue to produce products which cannot be used by these people without costly, extensive customizing.

The Objectives:

1. Locate all available resources, research projects in process, and related materials dealing with human factors of disabilities and environmental modifications;
2. Develop a format for presentation of this data in a way which can be easily understood and used by counselors, employers, designers/engineers of consumer products;
3. Test the utility of the new resource to these potential users;
4. Refine and complete the resource and disseminate.

METHODOLOGY: The stated objectives will be achieved through the following methodology during the six years of the project period:

1. Review of literature and development of human engineering format related to different environments (i.e., vocational, home, educational) through consultation with consumers, designers, educators, employers, engineers, rehabilitation professionals and students.
2. Compilation of a list of potential users will be established;
3. Need survey form will be developed and mailed to each user.
4. Respondents to the questionnaire will be randomly divided into control and study groups. The study group only will receive a copy of the developed resource.
5. A data gathering format will be designed and mailed monthly to both control and study groups.
6. The monthly data from control and study groups will be compared to determine the impact of the resource on enhancing the potential of disabled persons.

FINDINGS TO DATE:

1. Consumers, rehabilitation counselors, employers, designers, engineers and students are invited, through direct mailing and personal contacts, to express their information needs in the areas of human factors of disabilities and environmental modifications;
2. From this input, a format was developed for presentation of the most desired data in a clear, illustrative manner;
3. Data was collected from completed and ongoing research projects, published references and texts, human factors professionals, consumer groups, and client records and applied to the format;
4. A committee was formed from contacts made throughout the project to evaluate the preliminary format design; necessary changes were made;
5. Layout for the resource format has been designed:
 - A general looseleaf format for ease of use and updating;
 - Maximum use of graphic portrayal of data;
 - A summarization of architectural accessibility resources to provide the reader with access to this considerable information (also to avoid having to add to this bulk by duplicating it in this resource);
 - An introductory booklet designed to inform the reader, in lay terms, about each disability, to maximize facts and minimize myths and misunderstanding;
 - Cross-reference of disabilities so the reader will grasp common impairments among disabilities;
 - Use of "guidelines" rather than "rules" of human engineering data to encourage the reader to

understand the individuality of the disabled person:

- a. Provide employer with data helpful in planning environmental design when interviewing client;
 - b. Provide counselor with guidelines for planning job development;
 - c. Provide designers/engineers with understanding of variety of consumers' needs;
 - d. Provide families with general guidelines for planning home independence of disabled family member.
6. At this time, information needs surveys have been mailed to potential users to assemble a group of interested persons who will be randomly divided into test and control groups. Test and control groups will complete monthly data cards to track information needs. The data is expected to illustrate the usefulness of the resource in understanding human factors of disabilities and planning environmental modifications.

APPLICABILITY: The dilemma of the employer seeking the environmental implications of hiring the disabled, the counselor having little expertise to offer in this area, and the misunderstood client caught in the middle is a common occurrence. The Job Development Laboratory staff has experienced these circumstances on many occasions. Through a basic understanding of human engineering and extensive experience working with clients having various severe disabilities, simple solutions have been found, for example:

1. Instability in transfer with conventional narrow transfer boards prevented on-site employment for a Job Development Laboratory client with C4-5 spinal cord injury. By vacuum-forming a 16 inch wide plastic transfer board with a "fender" for sliding over the wheel, transfer, and therefore employment, was made feasible.
2. Inability to empty a leg bag prevented on-site employment for a spinal cord injured client. Refinement of a 2½ gallon wheelchair tank designed for another Job Development Laboratory client allowed free passage of fluids without necessity of emptying tank during working day.

A resource providing appropriate guidelines for setting up a functional environment for the disabled will aid in maximizing vocational rehabilitation service delivery.

143 Comprehensive Job Placement Models for State Vocational Rehabilitation Agencies

Principal investigators:	Kalisankar Mallik, M.S., M. Tech. Sheldon Yuspeh, M.S.	
Status:	Continuing	
Dates:	March 1978-February 1982	
Cost:	Annual \$63,125 RT Annual \$44,738	Projected Total \$320,000 RT % of Annual Total 71%
Annual Report Reference:	#14, Page 124, R-51	

OBJECTIVES: The objectives of this project are:

1. To develop innovative job placement models, based on concepts of service delivery already tested and refined by the Job Development Laboratory, which are consistent with the service delivery capabilities, constraints and preferences of state vocational rehabilitation systems;
2. To develop training formats for state vocational rehabilitation personnel to support the developed placement models.
3. To assess the need for such services and to provide state vocational rehabilitation systems with developed placement models and appropriate staff training in their use.
4. To monitor and measure the effectiveness of the developed placement models' utilization in the state vocational rehabilitation system through the analysis of caseload statistics.

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5. To disseminate the project's findings to all state rehabilitation agencies on the cost effectiveness of each developed model.

METHODOLOGY: To meet the project objectives, the project staff will conduct a four year research and demonstration project as described below:

1. Selection of advisory committee members;
2. Development of job placement models for use in state vocational rehabilitation systems;
3. Survey of state/federally supported vocational rehabilitation programs concerning their participation in the project;
4. Development of training materials and formats to support the placement models;
5. Collection of pre-training placement data;
6. Training of state vocational rehabilitation personnel:
 - a. Providing audiovisual and training materials to the participating state vocational rehabilitation agencies' designated staff
 - b. Conducting a five day training program at the Job Development Laboratory, RT-9, Washington, D.C.
 - c. On-site visit to provide more intensive training
7. Collection of post-training placement data;
8. Analyzing data in terms of effectiveness of the program.

FINDINGS TO DATE:

1. **Selection of Advisory Committee:** According to the Methodology, a representative group of individuals was requested to serve as members of the advisory committee. The members (state vocational rehabilitation counselor, training officer, job placement specialist, first-line supervisor, administrator, and consumer), with diversified rehabilitation backgrounds, were selected nationally to assist the project staff in refining research and placement models and training formats, and in reviewing and analyzing training outcome data.
2. **Development of Placement Models:** According to the comments and suggestions provided by the advisory committee members, the project staff revised the following job placement models: **Control group** (The Individual Counselor Approach); Study group: Model 1 (The Team Approach), Model 2 (In-House Technical Support to Individual Counselor Approach), Model 3 (Facilities Team Approach), and Model 4 (Job Placement Specialist Approach).
3. **Survey and State Selection:** The project selected one state from each of the ten federal regions as possible participants in the research and demonstration project. Since the project's resources limited us to work with approximately five states, on November 29, 1978 the staff requested each of the ten selected states to return a questionnaire by January 3, 1979 if they were interested in participating in this study. The following are the five states which were selected (on a first-come, first-served basis) to participate in the study and control models: New Hampshire, Region I; Virginia, Region III; North Carolina, Region IV; Michigan, Region V; and Iowa, Region VII.
4. **Training:** Training format and content have been developed to train approximately 23 members from the five state vocational rehabilitation agencies who will participate in the five day training program at The George Washington University (Research and Training Center, Washington, D.C.) on two separate weeks, one in September, one in October, 1979.
5. **Data Gathering Format:** A format was designed so that all required data could be easily compiled from R-300 information already collected by each state agency as required by the Rehabilitation Services Administration of H.E.W.

APPLICABILITY: The research staff of this project is planning to develop practical job placement models, complete with staff training packages, applicable to vocational rehabilitation service delivery systems for severely disabled persons. It is anticipated that adoption of such models into existing state vocational rehabilitation systems will facilitate gainful employment of severely disabled

clients and thereby help rehabilitation practitioners in implementing the Rehabilitation Act of 1973.

144 Emotional Responses in Subjects with Right Hemisphere Damage

Principal Investigator:	March Enders, M.D.	
Status:	Continuing	
Dates:	March 1978-February 1981	
Cost:	Annual \$16,023 RT Annual \$11,717	Projected Total \$47,000 RT % of Annual Total 73%
Annual Report Reference:	#14, Page 159, R-52	

OBJECTIVES:

Background: It is becoming clear from studies conducted over the past ten years that the right cerebral hemisphere has a special role in the comprehension of emotions and emotionally colored information, and probably also in the experiencing and expression of emotion.

To summarize, it is now generally thought that the right hemisphere is:

1. Superior in comprehension and expression of emotion.
2. Superior in storage of affective material.
3. Has a preferential emphasis on negative emotions.

Purpose: The present study is designed to determine whether or not right hemisphere damage results in a diminished experience of emotion in general or of certain specific emotions.

METHODOLOGY: The following subject and control groups are being studied:

Subjects: Patients with right hemisphere damage due to cerebrovascular disease, right-handed, ages 18-73.

Controls:

1. Patients with left hemisphere damage due to cerebrovascular disease, right-handed, ages 18-70 but with good comprehension, i.e., able to follow at least a two-stage command.
2. Patients without brain disease, but with chronic illness such as arthritis, heart or pulmonary disease, ages 18-70.

The following test instruments and data collection will be obtained:

1. Mental status examination: subjects must score 20 of the possible 30 to qualify for the study.
2. **Lorr Feeling and Mood Scale:** to be given to subjects weekly to rate themselves and to also be used by the patients' primary nurse as an objective rating scale. The patients will be rated serially beginning 3-4 weeks post-stroke.
3. Rating scale to be filled out by family member or close friend designed to detect their observations of any changes in the patient's effect.
4. OT ratings for left-sided neglect (4-point scale).
5. Primary Nurse Rating for emotional flatness (3-point scale).

FINDINGS TO DATE: 14 right hemisphere, 4 left hemisphere and 8 control patients have been studied. Rating by the subjects themselves and by the primary nurse correlate well for the emotions rated (cheerfulness, energy, anger, anxiety, depression, friendliness and self-confidence). The right hemisphere and control groups show very similar patterns on the Lorr Feeling and Mood Scale, while the left hemisphere patients show elevated levels of anger and depression. Tentatively, we have concluded that right hemisphere patients may not have an altered experience of emotion, but may instead have diminished emotional expressiveness.

APPLICABILITY: Damage to the right cerebral hemisphere is widespread among patients with disabilities, occurring as it does in cerebrovascular disease, and as a consequence of trauma and brain tumors. Of these, a considerable number of patients of all ages may have some type of emotional dysfunction as part of their disability.

This dysfunction can be distressing, in that it may result in altered and less satisfactory relationships between the patient and his family, rehabilitation team members and co-workers. Patients with affective dysfunction can become remarkably cut off from their normal support systems because of their difficulties in understanding and expressing appropriate feelings. It can be difficult for rehabilitation team members working with these patients to assess motivation and emotional responses to the treatment situation. Family members can be particularly distressed by the change in the patient's ability to communicate with them.

In addition to the interpersonal changes caused by affective dysfunctions, distinguishing between depression and emotional flatness can be a very difficult clinical problem in patients with right hemisphere damage; preliminary results in the use of the Lorr **Profile of Mood States** suggest that tests of this kind may be useful in distinguishing between the two conditions.

Enlargement of one's understanding of these affective changes is an essential first step toward the goal of providing more effective treatment and re-education techniques for patients with right-sided brain damage. New information gained from the present study could be used to enhance the effectiveness of the rehabilitation process in several ways. Patients themselves, families, rehabilitation personnel and vocational rehabilitation counselors could benefit from increased understanding of the nature of the emotional dysfunction and how it affects the patient's functioning. In addition, any new information could be used towards improved emotional functioning.

145 Training and Evaluation Program in the Utilization of Accessible Buses*

Principal Investigators:	Irene G. Tamagna, M.D. Donald W. Dew, Ed.D.
Status:	Continuing
Dates:	November 1978-November 1980
Cost:	Annual \$221,040 RT Annual \$50,000
	Projected Total \$460,618 RT % of Annual Total 23%
Annual Report Reference:	#14, Page 302, T&D-1

*This is a Training and Demonstration Project funded partially by the Department of Transportation and partially by RSA.

OBJECTIVES: The ultimate goal of this project is the maximum utilization of lift-equipped kneeling buses in the Washington Metropolitan Area. Specific project objectives are as follows:

1. Develop, package and conduct a sensitivity program for WMATA trainers.
2. Develop a model training program for rehabilitation professionals to utilize with handicapped persons on the use of public transit facilities and services, including lift-equipped kneeling buses.
3. From the consumer's perspective, evaluate the new lift-equipped and kneeling buses for accessibility and safety.
4. Develop a comprehensive evaluation component which will assess the impact on the handicapped of the newly accessible transportation system in the Washington Metropolitan Area.
5. Disseminate nationally the findings of the newly accessible transportation system project.

METHODOLOGY: It was decided to approach the training component of this project by a "Train the Trainer" approach. A three-day comprehensive training program on disability awareness was developed for 18 WMATA bus operator instructors who in turn would train WMATA's 2800 bus operators. The program was designed to allow instructors to examine their own attitudes as they relate to the disabled and elderly, communicate with consumers who have transportation handicaps, experience the feeling of a transportation-handicapped individual through simula-

tion, obtain information regarding disabilities and to learn how to properly assist disabled and elderly passengers. The second phase of this training program was to evaluate the three-day activity and condense the information into a three-hour comprehensive program for the 2800 bus operators, and to co-lead with each of the 18 instructors, their first three-hour disability awareness seminar. For this condensed three-hour awareness seminar, the project staff developed teaching aids which include a comprehensive instructor's manual, 12 charts, a book entitled "Accessible Bus Transportation, a Guide to Assisting the Disabled or Elderly Passenger," and two thirty-minute films entitled "Getting to Know You," a panel discussion in which consumers and bus operators share their concerns related to the new accessible bus system, and "The Accessible Bus, Guidelines for the Operator," a film illustrating the procedures involved with riding the bus.

The original plan which allowed for the project staff to co-lead one session with each of the 18 bus operator instructors was revised. The alternative approach was to have two instructors co-teach their first three-hour program with assistance from the project staff. Prior to the three-hour seminar, the project staff met with the instructors to review the training materials. Immediately after the program, an evaluation was held in which feedback was offered to the instructors on their presentation.

Another component of the project involves assessing the training. The bus operator trainers were pre-tested prior to participating in the three-day program. Two primary instruments were utilized: the Attitude Towards Disabled Persons Scale and a Disability Awareness Inventory. Two checklists were devised to determine expressed feelings and perceptions about disabled persons, and the new lift bus. Following completion of the three day sessions, the trainers were post-tested with the same instruments. An additional post-test was administered after each instructor conducted his first three hour seminar for operators.

Currently underway is an evaluation of the three-hour seminar for operators. A modified version of the Disability Awareness Inventory was developed for this purpose and is administered to the entire population of operators. A secondary aim of this evaluation is to determine the impact of new training materials as they are incorporated into the presentation.

Another major training component of this project is to train rehabilitation professionals, such as physical therapists, occupational therapists, nurses and rehabilitation counselors. This phase of the project has been planned to coincide with the implementation of the new lift-equipped and kneeling bus services. These rehabilitation professionals are scheduled to be trained within the next six months.

This phase of the training for the rehabilitation professionals is again based on the "Train the trainer" model. Once rehabilitation professionals have learned the skills needed for independent travel, they will be capable of teaching their clients how to utilize the accessible buses.

Mr. Kalisankar Mallik, Director of the Job Development Laboratory, and Ms. Judith Frank, Occupational Therapist with the Laboratory, are assessing the equipment for its usability and safety. Volunteer potential consumers were observed as they utilized the lift, maneuvered their chairs to the designated area for wheelchairs, and attempted to secure themselves in this area. Their ability to alight from the bus was also documented. The information gathered from these evaluation sessions is useful in assessing the need for either adaptive devices or modifications to existing equipment.

The concluding phase of the project will be dissemination of the materials developed for the training of transit authority and allied health personnel, as well as consumers. In addition, technical assistance will be offered to other transit authorities, universities, medical facilities and consumer groups. Project staff will be available to meet with transit authority personnel and other interested organizations to assist in the development and training for accessible transportation programs.

FINDINGS TO DATE: Using the three day program on disability awareness, all bus operator instructors have been trained and are familiar with the training materials. In addition, 1800 of WMATA's operators have participated in the three hour disability awareness seminar.

As a result of three day training bus operator instruction, instructors test scores showed significant positive changes in both attitudes toward and knowledge about people with disabilities. A follow-up evaluation is presently underway to determine the stability of change over time. Bus

operators who participated in the three hour disability awareness seminar also commented on the presentation using a one-page reaction sheet. This feedback showed that the materials were received in a positive manner and that the operators felt the seminar was both interesting and useful.

APPLICABILITY: An accessible transportation system for the handicapped is vital to the independence of handicapped persons. This project should have a major impact on the independent functioning of handicapped individuals and their families in the Washington Metropolitan area.

An accessible transportation system would make medical facilities and rehabilitation programs accessible so that therapy could be carried out on a regular basis. It would facilitate vocational rehabilitation of the handicapped by making employment opportunities accessible. The availability and reasonable cost of accessible public transportation increases the independent functioning of a handicapped individual in employment and leisure time activities. In essence, an accessible transportation system for the handicapped is a major step in involving the handicapped individual as an equal and active member of society.

146 Performance Capability and Vocational Potential of the ESRD Client

Principal Investigators:	Alvin E. Parrish, M.D. Norman C. Kramer, M.D. Wu S. Chiu, M.D. Kallsankar Mallik, M.S., M. Tech.	
Status:	New	
Dates:	March 1979-February 1980	
Cost:	Annual \$120,705 RT Annual 87,272	Projected Total \$120,705 RT % of Annual Total 72%
Annual Report Reference:	#14, Page 238, SR-10	

OBJECTIVES:

1. To determine whether a standard exercise could produce alterations in serum chemistries that might separate individuals with end stage renal disease into several groups.
2. To determine whether such separation could be related to the lack of return to previous physical activities.
3. To determine whether a program of planned exercise to improve physical capabilities could be developed.
4. To determine whether abnormalities seen on exercise could be reversed by increased dialysis time.
5. To identify medical, psychosocial, and vocational factors which are potentially predictive of the work capacity of ESRD clients.
6. To verify and measure the predictive value of identified medical, psychosocial and vocational factors.
7. To develop a measurement tool and predictor scale for evaluating work capacity potential and for isolating areas which impede increased work capacity potential of the ESRD client.

METHODOLOGY:

1. **Exercise Test:** Individuals were asked to walk on a treadmill for 10 minutes at a standard rate. During this time vital signs, including blood pressure, pulse and respiratory rate, were determined for intervals of 10 minutes, for a full 30 minutes. Blood samples were obtained before the exercise began, at 2 minute intervals during the exercise, and at 10 minutes post and 20 minutes post exercise. Blood samples were analyzed for potassium, pH, lactate, pyruvate, calcium and magnesium.
2. **Identification of potential work capacity predictors:** A listing of medical, psychosocial, and vocational factors, identified by prior research and literature review as significant to the vocational

rehabilitation of the ESRD client, will be prepared by project staff. All factors will be reviewed to identify those which show most promise of being predictive of the ESRD clients' work capacity. Medical and other rehabilitation professionals having expertise and current working experience with the ESRD population and ESRD clients will be consulted as part of the review process.

3. **Development of data collection instrument:** A self-administered questionnaire will be designed around factors felt to be most significant as predictors. This questionnaire will undergo a similar review to ensure that, when administered, it will provide data consistent with identified predictor variables. A vocational psychologist/statistician will be consulted to develop an appropriate response coding system for computer analysis prior to finalizing the questionnaire format.
4. **Data collection:** Project staff will seek cooperation from all metropolitan Washington dialysis units in order to maximize the potential client data base. A method for distribution and collection of questionnaires to center dialysis patients will be negotiated with each dialysis unit which agrees to participate in the study.
5. **Data Analysis:** Validity and reliability of variables as predictors of work capacity will be checked through multiple regression computer analysis techniques.
6. **Development of client assessment tool and work capacity predictor scale:** A revised questionnaire will be prepared for assessing client status in terms of medical, psychosocial and vocational factors found to be predictive of work capacity through computer analysis.

A format will be developed to recognize the distribution pattern of ESRD clients' evaluation scores (i.e., "cannot work," "homebound, part-time work," "homebound, full-time work," "onsite, part-time work," "onsite, full-time work"). The format will allow us to evaluate the following: (a) present work capacity potential; (b) correlation between the variables; (c) types of variables strongly related to increased work capacity. Instructions for administration of the questionnaire and use of the work capacity predictor scales will also be prepared.

FINDINGS TO DATE:

1. **Exercise Test:** The exercise test was standardized to a treadmill rate of 1.5 miles per hour. Blood samples were drawn as described in methods. Observations thus far indicate the following: (1) that many individuals undergoing hemodialysis are unable to undertake this degree of exertion for as long as 10 minutes without stopping. These individuals show development of quadriceps, pain and weakness which may interfere with their ability to complete the test. (2) Individuals undergoing hemodialysis who are undertaking the exercise tests show a marked increase in serum lactates above the resting level, after 6-8 months of exercise, following which their lactate level drops toward normal, at a rate not unlike that of normal individuals. The lactate pyruvate ratios in these individuals also increases; again to a marked degree. Differences between ESRD patients and normal controls are statistically significant. A group of 3 patients undertook regular, although unsupervised exercise consisting of jogging, in 2 instances, and bicycle riding in the third. These individuals considered themselves in better condition following this than previously; however, the exercise test was unchanged. Three individuals were dialyzed daily for one week, with improvement in their overall condition, but no change in their exercise test.
2. **Studies of Vocational Capability:** Project staff is currently completing Step 3 of the methodology: development of data collection instrument. A questionnaire was designed and submitted to medical and other rehabilitation professionals and knowledgeable ESRD clients for review. Reviewers were asked to evaluate each question for readability and wording to ensure that each question will provide data consistent with identified predictor variables established in Step 1 of the methodology. The questionnaire was revised accordingly and is now undergoing final review. It is anticipated that the questionnaire in final form will be ready for distribution to dialysis center patients in September 1979. Project staff is currently pursuing the cooperation and participation of dialysis units in the Washington Metropolitan area for the data collection phase of the project (Step 4).

APPLICABILITY: The findings of increased serum lactate with exercise which appear to be the metabolic accompaniment of uremic myopathy suggests that there is an important physical component to the inability of patients with end stage renal disease to return to gainful employment, and although the socioeconomic factors are important, this physical factor, unless it can be corrected,

suggests that there is a definite limit for the possibility of returning these individuals to their previous activities. This needs to be studied further.

It is expected that use of the completed Vocational Capabilities study will assist vocational rehabilitation professionals to evaluate: (a) present work capacity potential; (b) correlation between the variables; (c) types of variables strongly related to increased work capacity. The developed evaluation instrument and the work capacity predictor scale will also help to identify type and commitment of intervention strategy required to help ESRD clients in upward mobility.

147 Rehabilitation and Family Interaction: A Pilot Test of the Multiple Family Group on a Dialysis Unit

Principal Investigators: David Reiss, M.D.
Peter J. Steinglass, M.D.

Status: New

Dates: February 1979-January 1980

Cost: Annual \$41,609 Projected Total \$41,609
RT Annual \$30,252 RT % of Annual Total 73%

Annual Report Reference: #14, Page 265, SR-11

OBJECTIVES: The major objective of this pilot study is to explore the value to rehabilitation of the multiple family group. The multiple family group is a brief, inexpensive psychosocial intervention aimed at identifying needs of families of clients, reducing the stress on the family of dealing with chronic disability and improving the psychosocial outcome for the client.

METHODOLOGY: The multiple family group consists of 4-6 families and one to two professionally trained leaders. The group meets for 90 minutes weekly for a period of eight weeks. The primary emphasis in group discussion is on the current life issues, in each family, related to the chronic disability. Clients will be drawn from several dialysis centers in the Washington area. They and those members of their family which occupy the same household, will be the members of the group. The primary emphasis in evaluation will be direct clinical evaluation of the group itself. We need to learn more how to adapt multiple family group techniques for this type of family. As preliminary effort to make controlled comparisons, we will match clients and families who participate in the group with those, from the same Centers, who were not asked to participate. We will attempt a case-control match based on key demographic variables and severity of illness. A variety of standard rating techniques will be used to compare the two groups.

FINDINGS TO DATE: The study is just underway. Findings are not available.

APPLICABILITY: This pilot study should indicate the feasibility of the multiple family approach to assisting clients with a broad range of medically-based chronic disabilities.

148 Coronary Artery Disease Rehabilitation Program: The Controlled Trial of Structured Low Level Exercise in the Hospital Phase of Post-Myocardial Infarct Convalescence

Principal Investigators: Patrick A. Gorman, M.D.
Mary Ellen B. Newhouse

Status: New

Dates: February 1979-January 1980

Cost: Annual \$29,240 Projected Total \$29,240
RT Annual \$21,725 RT % of Annual Total 74%

Annual Report Reference: #14, Page 270, SR-12

OBJECTIVES: This study is a controlled trial of structured low level exercise in patients hospitalized for acute myocardial infarction. The object is to determine whether this intervention has a significant effect on rehabilitation outcomes.

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METHODOLOGY: Participants are recruited from the Hospital Coronary Care Unit. Patients are screened for the following: age 30-69, male or female, acute myocardial infarction with typical clinical presentation, diagnostic ECG and serum enzyme changes (at least 2 of these 3), clinical stabilization and willingness to enter the control or study group.

Eligible patients are assessed by depression and anxiety scales, adjective check list for physical and psychological well being, and social and occupational background.

Suitable patients are randomized to control or exercise groups.

The exercise group receives daily supervised exercise, flexibility in type, graded into 4 stages according to level of convalescence, fully described in a booklet given to the patient.

The control group does not receive exercise supervised by a physical therapist.

Follow-up evaluations are performed just before hospital discharge (day 10-14) and on day 40-45 post MI.

FINDINGS TO DATE: In the 20 weeks of project activity, the CCU had 209 admissions of which 53 or 25% had documented acute MI. Of the 12 who were eligible, 8 agreed to be randomized, 6 going to the intervention group and 2 to control.

Patients in the intervention group prior to discharge had mean heart rates of 75.3 and 83.8 at supine and standing rest; 88.8 and 97.3 after a 3 minute walk at 1.5 mph and simulated step climbing respectively. The mean anxiety and depression scores were within normal limits. Findings in the control group are similar.

At this early stage of the study no conclusions are looked for. No adverse reactions have occurred.

APPLICABILITY: At this stage, not applicable.

149 Rehabilitation Potential as a Function of Corticosteroid Therapy in Rheumatic Diseases: A Prospective Study

Principal Investigators: Robert P. Jacobs, M.D.
David G. Borenstein, M.D.

Status: New

Dates: January 1979-December 1979

Cost: Annual \$75,103 Projected Total \$75,103
RT Annual \$61,834 RT % of Annual Total 82%

Annual Report Reference: #14, Page 293, SR-13

OBJECTIVES:

1. To identify clinical and laboratory manifestations of systemic lupus erythematosus that limit rehabilitation potential;
2. To correlate quantitative clinical and laboratory parameters of selected musculoskeletal manifestations of corticosteroid toxicity with vocational and/or performance capability;
3. To assess selected noninvasive cardiovascular diagnostic techniques in the prospective evaluation of corticosteroid toxicity;
4. To identify corticosteroid-induced changes in psychosocial function that impair the rehabilitation process;
5. To develop criteria for assessing the role of corticosteroid toxicity in the rehabilitation process of patients requiring continuous, low-dose therapy;
6. To develop psychosocial and/or vocational intervention for patients with systemic lupus erythematosus to enhance rehabilitation outcome.

METHODOLOGY: This is a pilot project designed to assess the role of selected manifestations of corticosteroid toxicity in the rehabilitation process. Patients with systemic lupus erythematosus were

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selected for study because of the large doses of corticosteroids often required in the management of this disease and the young average age of the patient population.

1. **Disease Activity** (every four months)

Develop a quantitative scale of disease activity based on clinical parameters (history and physical examination) and laboratory tests recognized as indicators of disease activity.

2. **Corticosteroid Toxicity**

A. **Musculoskeletal**

(1) **Steroid myopathy** (every 4 months)

- a. Semiquantitative assessment of proximal muscle strength;
- b. Serum enzymes: creatine phosphokinase and isoenzymes; lactate dehydrogenase and isoenzymes; glutamic oxalacetic transaminase;
- c. Serum potassium;
- d. Urinary creatine/creatinine ratio; and
- e. Electromyography when clinical or laboratory data suggest muscle involvement.

(2) **Steroid-Induced Osteopenia** (0 and 12 months)

- a. Develop and implement methods to quantitate vertebral bone density by computed tomography;
- b. Peripheral bone density measurements by photon absorptiometry;
- c. Serum calcium, phosphorus, alkaline phosphatase, parathyroid hormone, 25-hydroxy vitamin D; and
- d. Urinary calcium

B. **Cardiovascular** (0 and 12 months)

- (1) Risk factor assessment, including nutritional history, lipoprotein quantification, fasting blood glucose and 2-hour postprandial glucose determinations;
- (2) Electrocardiographic stress testing; and
- (3) Two-dimensional echocardiography.

C. **Psychiatric** (every 4 months, excepted as indicated)

- (1) Schizophrenia and Affective Disorders Scale (SADS)—the lifetime version will be administered on entry to the study and the current version repeated at four month intervals. From the semi-structured interview the patient can be rated on the Hamilton or Beck Depression Inventories. Mental status examination information is contained in the SADS interview and can be extended by the interviewer where there are positive responses.
- (2) Social Adjustment Scale (Weisman)—administered at 0 and 8 months.
- (3) Cognitive Capacity Screening Examination.
- (4) Body Image Perception Scale—this instrument will have to be developed. Body image perception will be supplemented by determinations of weight, abdominal girth, and frontal and lateral photographs of head and upper torso.

3. **Functional Status:**

A. **Psychosocial Function**

- (1) See 2-C.

B. **Vocational Function** (every 4 months)

- (1) Functional Limitations Scale—This brief but comprehensive inventory will be used to evaluate and monitor vocational capacity and identify functional limitations, regardless of etiology.

FINDINGS TO DATE:

- 1. A lupus activity protocol has been developed.
- 2. A protocol for quantitative computed tomography of the axial skeleton is being developed. Data analysis will be based on the method of Orphanoudakis, et al. (Investigate Radiology 14:122, 1979). Data is being generated on a tissue-equivalent phantom and programs are being written.

APPLICABILITY: Corticosteroids are used in all medical disciplines and often provide dramatic improvement of serious medical disorders. While serious toxic manifestations of these drugs are well known and respected, their effects on the rehabilitation process are often overlooked. This study is attempting to demonstrate that corticosteroids limit the rehabilitation outcome of patients requiring continuous corticosteroid therapy. By identifying those toxic manifestations that impair the rehabilitation process, intervention strategies can be developed to enhance the outcome of a total therapeutic program.

150 Counseling Needs of the Families of Aphasic Patients

Principal Investigator:	Craig W. Linebaugh, Ph.D.	
Status:	New	
Dates:	March 1978-February 1980	
Cost:	Annual \$8,563 RT Annual \$6,129	Projected Total \$17,500 RT % of Annual Total 72%
Annual Report Reference:	#14, Page 165, R-53	

OBJECTIVES:

1. To determine what information and counseling the families of aphasic patients have received.
2. To determine which problem areas are most frequently associated with aphasia and which are of greatest concern to the families of aphasic patients.
3. To determine the optimum manner for providing the information and counseling needed by the families of aphasic patients.
4. To develop an objective means of determining individual family member responses to counseling.
5. To develop an objective means of assessing the effectiveness of counseling programs.
6. To isolate a set of factors by which those families most in need of counseling services may be identified, early in the rehabilitation process.

METHODOLOGY: The procedures employed included completion of a questionnaire by various spouses, offspring, and parents of aphasic patients and a follow-up interview designed to obtain information regarding the counseling they had received and their opinions regarding how counseling could best be made available. The spouses of the patients included in the study also made ratings of their aphasic partner's communicative abilities which were compared with similar ratings made by a certified Speech-Language Pathologist who was familiar with the patient. The spouses were also asked to rate their confidence in their judgements of the patients' communicative skills.

The results of the questionnaires were compiled with regard to the primary areas of concern, counseling which had been offered, and how that counseling might have been more effectively provided. In addition, an "accuracy-by-confidence" analysis was performed wherein the spouses' ratings of the patients' communicative skills were compared to those of the Speech-Language Pathologist and their confidence in their own judgments. This analysis permitted the dividing of the spouses into 4 groups as follows: (1) high accuracy - high confidence, (2) low-accuracy - high confidence, (3) high accuracy - low confidence, (4) low accuracy - low confidence.

FINDINGS TO DATE: A total of 43 family members of 25 aphasic patients have been included in the study to date. These included 21 spouses, 17 offspring, and 3 parents. Eighty-one percent of the spouses, 59% of the offspring, and 100% of the parents had received counseling regarding the patient's aphasia; all reported that the counseling was beneficial. Primary areas of concern included physical problems, emotional adjustment of both the patient and the family members, how best to communicate with the patient, and prognosis. Nearly all of the family members reported changes in their relationship with the patient and shifts in family responsibilities, yet subjects such as emotional adjustment, depression, irritability, and fatigability were infrequently discussed. Only 29% of the spouses received information on how to cope with emotional problems and 48% received information on how to facilitate communication. Ninety-five percent of the spouses responded, however, that they would employ specific techniques to deal with these problems

had they been provided. Eighty-five percent of the spouses felt that they now had an adequate understanding of aphasia and its implications, but 53% responded that they were still much in need of counseling. This finding indicates that knowledge about the disorder alone is insufficient to insure adequate adjustment.

In the accuracy-by-confidence analysis, 5 of the spouses fell into the low accuracy - high confidence group, 2 in the low accuracy - low confidence group, 4 in the high accuracy - low confidence group, and 7 in the high accuracy - high confidence group. It may be suggested that the first two groups are in need of both additional information regarding their spouse's communicative abilities and support, the third group in need of considerable support, and the fourth group in need of somewhat less support.

APPLICABILITY: It is generally agreed that the family of an aphasic patient is to be considered an integral part of the rehabilitation team. The findings of this study, however, revealed that 26% of the family members had not received formal counseling and of those who did, 30% felt that the counseling that they had received was inadequate. Clearly these results indicate that the counseling services provided to the families of aphasic patients must undergo substantial revision. Initial directions for this revision may be obtained from the family members' opinions regarding the nature and content of counseling. In addition, the accuracy-by-confidence analysis employed in the study provides an objective means of determining the outcome of counseling efforts directed toward individual family members, as well as assessing the efficacy of counseling programs. Finally, the isolation of a series of factors by which those spouses most likely to encounter adjustment problems can be identified early in the rehabilitation process will permit the provision of special counseling services where indicated and allow for the more efficient allocation of staff time.

151 Identification and Quantification of Biomedical Variables which Affect Learning Behavior and Rehabilitation Outcome After Cerebral Injury

Principal Investigator:	Gaetano F. Molinari, M.D.	
Status:	New	
Dates:	March 1978-February 1980	
Cost:	Annual \$40,231 RT Annual \$28,081	Projected Total \$90,000 RT % of Annual Total 70%
Annual Report Reference:	#14, Page 178, R-54	

OBJECTIVES:

1. To test prospectively the prognostic validity, accuracy and reliability of the variables recently reported by Feigenson (7, 8) from a retrospective study, namely, that age over 80, underlying organic mental syndrome, homonymous hemianopsia on the affected side, prolonged latency from onset of symptoms to admission to rehabilitation services all mitigate against a successful recovery after brain injury.
2. To test the feasibility of a unique method of application of the visual evoked response as a prognostic tool. Application of a special adaptation of the visual evoked response to patients with hemianopsia developed under the first year's activities of this project may specifically identify hemianopsia in the aphasic patient, and quantitative assessment may predict reversibility thereby indicating a more favorable prognosis.
3. To continue developing the visual evoked response and begin preliminary or pilot studies to evaluate the potential for application of the auditory evoked response and the somatosensory response to prediction of reversibility or potential recovery from hemispherical lesions in a rehabilitative therapeutic setting.

METHODOLOGY:

1. Patients with stroke or other intracranial lesions who have lesions in the posterior (post rolandic) quadrants of the brain on either side as determined by routine diagnostic CAT scans.

The modification of the visual evoked response developed during the first year of activity of this

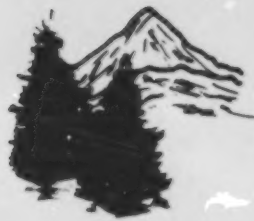
project is used to stimulate posterior visual pathways of the two hemispheres independently.

2. Adequate control data have been accumulated from normal volunteers so that reliable and reproducible tests of hemispherical conduction of visual stimuli and the morphology of visual cortical responses are known and recognized.
3. Additional control data from patients without structural lesions is being gathered from migrainous volunteers.
4. Patients presenting to the neurological unit with aphasia are tested with the "partial field pattern reversal visual stimulation" technique whether or not the lesion seen by either CT scan or radio-nuclide brain scan involves known visual pathways.
5. Additional technical refinements are in development and these developmental engineering procedures will be continued.
6. Data used in formulating a prognosis are: (a) age; (b) presence or absence of an underlying organic mental syndrome, screened by the test now in general use on the neurology service (9); (c) the presence or absence of hemianopsia either clinical or proven by visual evoked response; and (d) the latency between the onset of symptoms and presentation to the hospital, (controllable) summated with the somewhat controllable latency between accession to health care and accession to rehabilitative services.

FINDINGS TO DATE:

1. All instruments in use as measurements of intellectual function are not applicable to aphasic patients during the acute and early convalescent stages of stroke including the "Screening for Organic Mental Syndromes in the Medically Ill" (Ann. Int. Med. 86:40-46, 1977) tested in this project.
2. The hemispherical modification of visual evoked response designed and developed in this project does permit identification of visual field defects in aphasic patients as soon as they are able to sit up. The technical feasibility has been well established in 25 controls and 20 patients.
3. The absence of a cortical evoked response corresponded well with lesions identified by CT scans which affected the visual cortex, while white matter lesions of the optic radiation cause delay in latency.
4. Visual evoked responses have been studied in a total of 65 patients, 45 of whom were studied using orthodox methods for detection of early or residual impairments in retinal and/or optic nerve function.
5. In conjunction with this project a plan has been developed for the detection of total brain mass by CT scan, and for quantitative analysis of all abnormally low brain rhythms. New equipment has been installed in the Neurology Department (at no expense to RT-9) that will permit not only cortical evoked response measurement but also complete frequency spectral analysis. The combination of quantitative neuroanatomy measured by CT scanning adapted to reflect brain mass (volume) digitally and quantitative neurophysiology brain slow wave analysis, will be tested as parameters of learning capacity reflected by formal, quantitative psychometrics in a later study.

APPLICABILITY: The ability to identify early the presence of a right homonymous hemianopsia in an aphasic patient independent of the patient's ability to communicate would be a very significant advance in identifying not only prognosis but also the problems in learning behavior that would complicate rehabilitative therapy. Also the quantitative differences between reversible and irreversible hemianopic defects as quantified by VER would be a significant refinement in prognostic assessment of patients with central nervous system lesions.



**University of Colorado (RT-10)
Medical Rehabilitation Research and Training Center**

CORE AREA

Cardiopulmonary Rehabilitation

Research undertaken by the Center is practical, patient/client-oriented clinical research that is primarily derived from or utilized in the comprehensive patient care program for both in-patients and out-patients with coronary atherosclerotic heart disease. The coordinated research program dealing with major physiologic and psychologic problems in cardiopulmonary rehabilitation is designed to have a potentially direct impact on the primary or secondary prevention of disease or the prevention or modification of disability due to disease.

UNIVERSITY OF COLORADO

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COMPLETED

ABSTRACT NO.

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DISCONTINUED

Influence of Cardiovascular Function and Physiological Stress Loads on Psychological Efficiency (Revised:
Hypoxia and Cognitive Functions in Cardiovascular and Obstructive Pulmonary Disease Patients.)

PROPOSED

A Physiologic Comparison to Holding on Versus Not Holding During Maximal Treadmill Exercise: Obser-
vations in Normal Men

Contribution of Anxiety Management Training and Physical Conditioning to Stress Reduction and
Cardiovascular Fitness

Carbonic Anhydrase and Disequilibrium Acid-Base States

Metoprolol - Propranolol: An Evaluation of the Response to Maximal Exercise in Persons taking Doses of
Metoprolol and Propranolol

152 The Effect of Maximal Aerobic Exercise on Coagulation in Normals and Atherosclerotic Coronary Heart Disease Patients

Principal Investigator: H.L. Brammell, M.D.
 Status: Completed
 Dates: December 1977-December 1978
 Cost: Annual \$8,300 Projected Total \$8,300
 RT Annual \$6,700 RT % of Annual Total 80%
 Annual Report Reference: #14, Page 22, R-14

OBJECTIVES: This pilot study was undertaken to evaluate the coagulation status of a small group of normals and patients with atherosclerotic coronary heart disease and to observe what changes, if any, result from maximal aerobic exercise.

METHODOLOGY: Ten normal subjects and ten post-myocardial infarction patients were evaluated before and after maximal treadmill exercise. The treadmill evaluation included a resting recumbent and standing 12-lead scalar electrocardiogram, continuous monitoring of the electrocardiogram throughout exercise and post exercise tracings immediately 1, 2, 5 and 8 minutes following exercise. Blood pressure was recorded at rest and each minute during exercise. Expired air was measured with the physiologic monitoring system (see R-9) and observations made of ventilation, oxygen consumptions, CO₂ production, and respiratory quotient.

Blood was drawn without trauma (10 ml) before and immediately following maximal exercise. Coagulation factors evaluated included anti-thrombin III ReACT and ReACT plus 0.5 unit Heparin and Sonoclot, a measure of whole blood clotting. Sonoclot observations included time of onset, rate of clot formation, time to maximum clot formation, the ratio of rate of clot formation to time of onset and maximum height of Sonoclot trace.

FINDINGS TO DATE: No S or N took medication known to affect clotting within 10 days of the study. N were younger—35.4 years (25-43) vs. 53.8 (40-61) and more fit—VO_{2max} 41.8 cc/kg/min (34.3-60.1) vs. 27.4 (17.8-39.7).

Resting values were normal in N; S tended toward hypercoagulability. Exercise changed all clotting studies in N toward hypercoagulability ($p < .05$) except peak Sonoclot height. Exercise had no effect on clotting in S at rest. Following exercise, AT III, rate and ratio (onset/rate) of Sonoclot separated N from S ($p < .025$). Exercise did not improve discrimination between N and S.

	Pre-Ex. S	Pre-Ex. N	Pre-Ex. S	Post-Ex. S
	Post-Ex. S	Post-Ex. N	Pre-Ex. N	Post-Ex. N
AT III	NS	.088	< .001	.014
ONSET	.023	.001	NS	NS
RATE	NS	< .001	< .001	.004
RATIO-O/R	.026	< .001	.003	.025
PEAK TIME	NS	.047	NS	NS
PEAK HEIGHT	NS	NS	NS	NS
ReACT	NS	.001	NS	NS
ReACT+0.5 HEP	NS	< .001	NS	NS

The coagulation response to exercise differs in N and S.

APPLICABILITY: Atherosclerotic coronary disease may be due to intravascular thrombosis (one of several theories of the etiology of atherosclerosis) and is certainly associated with an increased incidence of thromboembolic episodes. This pilot effort has shown that those with atherosclerosis tend to be hypercoagulable relative to normals and two of the ten patients with coronary disease were clearly abnormal as evidenced by their very short anti-thrombin III times. These data raise some important questions:

1. Does the coagulation status of individuals change prior to an acute clinical event, that is does the coagulation profile have predictive value?
2. Is it possible to select a high risk group by coagulation studies and by selection of a proper anti-clotting agent prevent clinical events and disability?

153 Echocardiographic Assessment of Ventricular Motion During Exercise

Principal Investigator: Donald Dick, Ph.D.
Status: Completed
Dates: October 1976-October 1978
Cost: Annual \$1,200 Projected Total \$1,200
RT Annual \$1,200 RT % of Annual Total 100%
Annual Report Reference: #14, Page 49, R-162

OBJECTIVES: At the present time, echocardiography is helpful in the diagnosis of several types of cardiac disorders. In addition, this non-invasive tool has been used to evaluate certain aspects of left ventricular performance and has substantial value in this area. The use of ultrasound during exercise has not been systematically evaluated, either from an instrumentation or clinical point of view, and this is the principal objective of this project.

METHODOLOGY: Specific methodology for this project will include establishing limits for conventional ultrasound transducers, and the design, fabrication, and testing of new transducers with broader ultrasonic beam patterns. Testing and evaluation of the performance of these methods and systems during exercise with both normal and cardiac patients will be completed.

FINDINGS TO DATE: Most but not all of the project objectives have been achieved. Using conventional ultrasonic equipment the rotational limits of the transducer have been tested and with the subject in an upright position the transducer can be angled 15° in any direction and an interpretable echo through the left ventricular cavity obtained. Researchers designed, modified and tested a variety of transducers for use during exercise and obtained the best results with a 6 mm 2.25 MHz 1-3 cm short focus transducer. Five transducers were evaluated. While the 6 mm 2.25 MHz transducer gave the best results, this is not to say that it is the only unit which might function effectively. Other units included 13 mm 2.0 MHz standard unfocused transducer, a 13 mm 2.0 MHz defocused, 13 mm 2.0 MHz focused, and 6 mm 2.25 MHz 7.5 cm focused transducers. The transducer harness employed was simply a 4x4x1½ inch piece of stiff sponge through which a small hole was cut to accept the transducer. The sponge and transducer were then held in place on the subject's chest by an elastic bandage. This simple formulation provided adequate echocardiographic tracings at low intensities on the treadmill.

Development of the microprocessor-based ultrasound system continues, a transmitter/receiver has been designed, constructed and is working. When completed the microprocessor-based ultrasound system will feature automatic adjustment of many previously manual settings, e.g., time gain compensation.

Work on this project was deferred in 1978 because project personnel who were to provide the instrumentation expertise for the clinical trial of the exercise echocardiography system left the University and were not available to assist in the completion of the project.

APPLICABILITY: In recent years the echocardiographic assessment of ventricular function has shown great promise and value, but it is expected that the value of this technique can be greatly enhanced by engineering applications to situations of cardiac stress, e.g., exercise.

154 Relaxation Training and Aerobic Performance

Principal Investigator: Richard Sulinn, Ph.D.
Status: Completed
Dates: Completed December 1978
Cost: Annual \$843 Projected Total Not Applicable
RT Annual \$843 RT % of Annual Total 100%
Annual Report Reference: #14, Page 16, SP

OBJECTIVE: To determine the effect of anxiety management training on the energy cost of steady state aerobic exercise.

METHODOLOGY: Eight men and eight women were recruited from the Colorado State University cross country teams. Half of each group participated in anxiety management training, the remainder acted as controls. A baseline maximal treadmill exercise test was performed in the Human Performance Laboratory at the University of Colorado Medical Center early in the competitive cross-country season. The experimental group was trained in anxiety management training in eight one-hour sessions. The anxiety management training was conducted in three stages: (1) subjects were taught a procedure of deep muscle relaxation to achieve a heightened state of muscular relaxation and decreased state of autonomic nervous system functioning, (2) subjects were stressed by the use of stressful imagery to teach the subjects what happens to them physiologically as they **begin** to experience tension, and (3) subjects were stressed, and then taught by means of Q to reduce the stress and achieve a comfortable state of relaxation. The goal was to reduce stress and induce relaxation within thirty seconds.

At the end of the competitive season subjects were once again evaluated during steady state exercise. These retest procedures were performed during final examination week, and therefore, limited participation was obtained. Subjects were exercised at 65%, 75%, and 85% of the heart rate at which the anaerobic threshold occurred on the initial maximum exercise evaluation. Subjects were brought to the target heart rate while exercising on the treadmill, and when this heart rate was stabilized, continuous monitoring of ventilation, oxygen consumption, CO₂ production, respiratory rate, tidal volume, blood pressure and heart rate was begun. The initial command was for subjects to "run normal." After ten minutes of exercise, the subjects were given a written command "run relaxed." The workload was not changed, and the physiologic observations were continued.

FINDINGS TO DATE: Data acquisition was completed on this study in December 1978, and is currently being statistically analyzed.

The trend which has been observed is:

1. For the anxiety management training (AMT) subjects to decrease ventilation, respiration frequency, oxygen and consumption, especially early in exercise, and
2. they tend to "escape" during a 20 minute exercise period which suggests the need for reinforcement of the relaxation command during activity.

Not all subjects with AMT training were able to decrease 3 parameters which suggests a particular personality is required. New techniques may have to be developed for these and there may be a need to characterize the ones who can learn AMT.

Four control subjects have been studied - one decreased respiratory frequency at the higher workload during the run/relaxed segment, one increased respiratory frequency and decreased tidal volume at the 65% level. There was no change in ventilation or oxygen consumption in any subject in the control group.

APPLICABILITY: If one could decrease energy costs of vocational/recreational activities by relaxation, another "work simplification" technique would have been identified. This, coupled with clear benefits of stress management on quality of life would increase its importance/value as a component of cardiac rehabilitation programs.

155 Increased Density of B-Adrenergic Receptors on Lymphocytes Following Propranolol Treatment

Principal Investigator:	Alan Nies, M.D.	
Status:	Completed	
Dates:	Completed December 1978	
Cost:	Annual \$9,210 RT Annual \$2,910	Projected Total \$3,000 RT % of Annual Total 20%
Annual Report Reference:	#14, Page 11, SP	

OBJECTIVE: To evaluate B-adrenergic receptor density during and following withdrawal of oral pro-

panolol administration and to assess the associated physiologic response to exercise and orthostasis.

METHODOLOGY: Compensatory changes in the density of B-adrenergic receptors have been observed in rats following increases and decreases in receptor activation. It has been suggested that an increase in B-adrenergic receptor density might account for some of the complications of abrupt withdrawal to propranolol (P) in some patients with coronary heart disease. We have investigated the effects of P (160 mg/day for 8 days) on B-adrenergic receptors in 12 normal volunteers. Direct binding assays using the radioligand iodohydroxybenzylpindolol were performed on membranes from isolymp purified lymphocytes. Heart rate, blood pressure and graded exercise testing were used to assess the physiologic effects of P withdrawal.

Exercise studies were performed on a bicycle ergometer (Quinton Uniwork) with 100 kgm-m/min. increment in work load until a maximum effort was achieved. Ventilation ($\dot{V}_E$), $\dot{V}O_2$, $\dot{V}CO_2$, R, tidal volume and respiratory rate were recorded every 30" using the physiologic monitoring system in the cardiac rehab lab. The EKG and blood pressure were obtained and recorded at the end of each minute of exercise. Exercise evaluations were obtained before drug administration and 1 and 2 days following sudden withdrawal of the drug.

FINDINGS TO DATE: A $40 \pm 6\%$ increase in B-adrenergic receptor density was seen following 5 or more days of P treatment which achieved plasma levels of 34.1 ± 4.0 ng/ml immediately prior to a dose. 24 hours after the last dose of P the plasma concentration had fallen to <4 ng/ml. However, the density of receptors did not return to control levels for 4-7 days. Physiologic supersensitivity was suggested by the pulse rise on standing increasing from a control value of 13.8 ± 2.1 /min to 28.0 ± 3.4 /min ($p < .01$) 48 hours after stopping P. These data demonstrate that P administration results in increased density of B-adrenergic receptors which persists after the drug has been eliminated from the body, and lymphocytes are a readily accessible tissue in which to study the effects of chronic drug administration on B-adrenergic receptors in man. The results support the hypothesis that some of the effects observed clinically following abrupt cessation of P may be due to the increased number of B-adrenergic receptors.

APPLICABILITY: It is estimated that there are over 4 million citizens of the U.S. who have atherosclerotic coronary heart disease with varying levels of disability. In patients who have acceptable pump function propranolol is a commonly prescribed, indeed favorite drug employed to control symptoms of myocardial ischemia and abnormalities of heart rhythm. It has been believed for some time that sudden withdrawal of this drug was associated with an increased likelihood of life-threatening cardiovascular complications, but the patho-physiologic basis for this observation has not been apparent. If a mechanism could be identified, then support for the current practice of gradual withdrawal of the drug in situations where withdrawal is indicated would be apparent. Furthermore, if the mechanism is identified, the potential would exist for better managing patients in whom sudden withdrawal from propranolol was mandatory.

156 Early Adjustment to Steady and Unsteady Exercise in Patients with Cardiopulmonary Disability

Principal Investigator: H.L. Brammell, M.D.

Status: Continuing

Dates: October 1975-May 1979

Cost: Annual \$77,804 Projected Total \$250,000
RT Annual \$77,804 RT % of Annual Total 100%

Annual Report Reference: #14, Page 65, R-9

OBJECTIVES:

1. To acquire a computer-based physiologic measurement system to monitor ventilation, oxygen consumption, and carbon dioxide production rapidly and on-line.
2. To evaluate the adjustments to steady and unsteady state exercise in patients with and without cardiopulmonary disorders.

METHODOLOGY:

1. Construction of a physiologic monitoring system composed of a computerized data acquisition system and mass spectrometer (total gas and flow analysis instrument).
2. Utilizing the monitoring system to evaluate small groups of patients to:
 - a. Establish normal oxygen deficit data in subjects without cardiopulmonary disease.
 - b. Evaluate the hypothesis that oxygen deficit is greater in patients with functional impairment (New York Heart Association Class II or III) than in normals.
 - c. Evaluate the oxygen deficit response in patients with angina pectoris.
 - d. Evaluate the early adjustment to exercise in patients with varying degrees of obstructive lung disease.

Analysis of expired air during treadmill exercise, utilizing a bag collection system, carbon dioxide analyzer and fuel cell oxygen analyzer, was done on subjects. The following are some of the observations that were made or computed: minute ventilation, oxygen consumption, CO_2 production, respiratory exchange ratio, METS, anaerobic threshold, percent of maximum oxygen consumption at which anaerobic threshold occurs, heart rate, exercise electrocardiogram repolarization changes and abnormalities in heart rhythm, and blood pressure. Protocols were specific to the groups evaluated.

FINDINGS TO DATE: Studies completed with the progress of this project include:

1. Elderly female conditioning
2. Professional football player oxygen consumption evaluation
3. Marathon studies—young and old, showed a decrease in oxygen consumption max, but no change in % of oxygen consumption max at anaerobic threshold. Holter monitor study during a run at anaerobic threshold shows marathon runners have arrhythmias.
4. Anaerobic threshold in post-myocardial infarction males - results of Phase II program show no change in oxygen consumption max; marked improvement in anaerobic threshold. This has many implications for rehabilitation.
5. Adjustment to Standard Balke Exercise Test before and after physical conditioning speaks to the question of conditioning modifying the rate at which one adjusts to change in workload.

It is apparent from these studies that the anaerobic threshold can be favorably modified in cardiac subjects. This improvement in the onset of anaerobic metabolic pathways is more marked for the percentage of maximum oxygen consumption than for the percent of maximum heart rate at which the anaerobic threshold appears. The significant improvement in the level of oxygen utilization and METS at the point of the anaerobic threshold indicates that with anaerobic training, the cardiac can perform work, recreational and conditioning activities of a considerably higher level without utilizing anaerobic metabolic pathways and increasing blood lactic acid concentrations. In addition, since work at a level which exceeds the anaerobic threshold is associated with muscle ache, muscle fatigue, hyperventilation and often nausea, the aerobically conditioned client should be able to work at a higher intensity and remain comfortable. An increase in productivity and decrease in rest requirements while at work should result although this is not proved.

The physiologic monitoring system employs CO_2 analyzer (Beckman LB-1) fuel cell oxygen analyzer, hot-film anemometer (Thermo-Systems, Inc.) and a fully dedicated MicroNOVA computer (Data General) for on-line measurement of ventilation data: $\dot{V}_E$, $\dot{V}\text{O}_2$, $\dot{V}\text{CO}_2$, RQ , tidal volume, respiratory frequency and METS. These data are printed (Texas Instruments Silent 700) each 30 seconds. The respiratory mass spectrometer has been functioning in the laboratory of Dr. George Swanson where he has been conducting studies on multiple gas re-breathing techniques to assess lung water. In addition, he has been writing computer programs for the on-line non-invasive assessment of cardiac output which will permit breath by breath cardiac output data. These programs will be directly applicable to RT-10 computer support and are expected to be in place late in 1979.

APPLICABILITY: Methods which can detect physiologic changes that have the potential of early detection of deterioration, that suggest treatment modification and thereby maintain home, community, and vocational viability have great potential impact on the rehabilitative process. The long-range

goal of this project when the monitoring system is completed is to record a series of important physiologic observations longitudinally on patients with cardiopulmonary disorders and to use these physiologic data as indicators of work modification and hopefully as predictors of rehabilitative success or failure.

157 Sequential Evaluation of Sensitivity and Predictive Accuracy of Treadmill Testing Following Myocardial Infarction

Principal Investigator: H.L. Brammell, M.D.
Status: Continuing
Dates: May 1977-December 1979
Cost: Annual \$30,249 Projected Total \$70,000
RT Annual \$30,249 RT % of Annual Total 100%
Annual Report Reference: #14, Page 108, R-11

OBJECTIVES: To test the following hypotheses:

1. That low sensitivity of the graded exercise test following myocardial damage is common.
2. That the low sensitivity following the acute myocardial infarction may explain the generally low sensitivity of treadmill tests in published series.
3. That a change from a normal to an abnormal repolarization response following myocardial infarction is predictive of new coronary events.

METHODOLOGY: All patients with a history of acute myocardial infarction who have had at least one graded exercise test in which the heart rate equalled or exceeded 85% of age-corrected maximum heart rate, or who reach a maximum tolerated level of exercise will be included. No patient taking a digitalis preparation, with electrocardiographic evidence of left ventricular hypertrophy, or non-specific repolarization changes at rest will be included in the study. Patients on propranolol will not be excluded on heart rate criteria. Since many patients have been followed for several years, all exercise tests performed on each patient will be evaluated. Each electrocardiogram and graded exercise test tracing will be read by two staff cardiologists without knowledge of the patient's name or subsequent history. A system for coding each patient visit to the exercise lab has been devised.

Patients enrolled in the cardiac rehabilitation program at the University of Colorado Medical Center have their first treadmill experience approximately 2 weeks after leaving the hospital. This is repeated at approximately 8 and 12 weeks following infarct, the latter time being the first maximum tolerated test. Exercise tests are then performed at 6 months following infarction and every 6 months thereafter. The data regarding sensitivity and predictive accuracy for true positives can therefore be calculated sequentially in this group of patients.

FINDINGS TO DATE: In early 1978 the computer to be used for storage of patient records was received. Upon receipt of the computer and reviewing the requirements of the project it became quite apparent that the simple coding system outlined last year for interpretation of the exercise electrocardiograms would be inadequate to answer all the questions raised in this proposal. Therefore, an initial task has been to create a more comprehensive patient data sheet for the exercise evaluations. This data sheet will be used to compile the data obtained by the Center over the past several years and in addition will be adopted for all prospective studies. We anticipate that certain changes will need to be made in the form as experience is gained with its use, however, in its current format it will permit us to complete this study within the next fiscal year.

At this time, the data are too preliminary and the available numbers too small for statistical analysis. Progress will continue on this project although it would be judged to have lower priority than the studies proposed.

APPLICABILITY: It is anticipated that if the population from which a patient submitted to a graded exercise evaluation is known, greater confidence/lack of confidence in the repolarization response can be applied to interpretation of the test. This, of course, does not mitigate against the great value of exercise stress testing in determining functional capacity and providing rational counseling for vocational, recreational, and reconditioning purposes.

158 The Effect of Low Level Aerobic Conditioning on Exercise Tolerance in Left Ventricular Dysfunction

Principal Investigator: H.L. Brammell, M.D.
Status: Continuing
Dates: June 1977-May 1980
Cost: Annual \$11,240 Projected Total \$16,000
RT Annual \$9,478 RT % of Annual Total 84%
Annual Report Reference: #14, Page 126, R-12

OBJECTIVES:

- a. Determine the safety of low-level supervised exercise in patients with left ventricular dysfunction.
- b. Evaluate the efficacy of physical conditioning as regards:
 1. improved functioning capacity
 2. change in physiologic indicators of conditioning.

METHODOLOGY: Twelve male patients will be selected with LV dysfunction as a result of coronary artery disease and documented by cardiac catheterization. Any other cause of pump failure will be excluded.

Each subject will act as his own control; the individual changes noted as a result of exercise will be monitored.

All patients will continue under the care of their own physician and will continue to follow his recommendations as to diet and medication. Approval of private physician for participation in study will be obtained. Data from study will be made available to attending physician.

Subjects will all agree to a fourteen week study and will sign appropriate consent forms. Each patient's chart will be reviewed and summarized.

On the basis of the subject's maximum tolerated heart rate (MHR) the training heart rate (THR) will be determined. Eighty-five percent of the patient's MHR will be the THR and should give a training effect. This will be the conditioning heart rate prescribed for each subject.

Training is probably best achieved when the subject reaches his THR and sustains it for 30 to 45 minutes at least 3 to 5 times weekly. Subjects participating in this study will be exercised in groups of six at their THR 3 times weekly for 34 minutes. All of the training exercises will be aerobic; anaerobic activities will be avoided.

During the training exercise sessions the following will be monitored:

- a. Subjective status. Pre-exercise the subject will be asked how he feels and will not be exercised if there is any change in cardiac status, if he has contracted any cold, other infection or has other limiting changes in his health status.
- b. Blood pressure will be taken before and immediately after the session.
- c. Heart rate and rhythm will be monitored before, during each exercise and throughout the post exercise period with telemetry (Electrodyne).
- c. Heart rate and rhythm will be monitored before, during each exercise and throughout the post exercise period with telemetry (Electrodyne).
- d. All activities will be conducted in the Human Performance Laboratory, Webb-Waring Institute. All personnel involved in the study are certified by the American Heart Association in Basic Life Support. Equipment for cardiopulmonary resuscitation is maintained in the laboratory at all times.

Two baseline evaluations will be performed within a two week period. After three weeks of supervised exercise a complete evaluation as described earlier will be repeated. A new THR will be computed and an exercise prescription change made if necessary. Subjects will then continue the exercise program for three additional weeks. If no evidence of conditioning is seen, additional weeks of conditioning will follow. A total of 12 weeks may be required to determine if an optimal conditioning effect has occurred.

At the end of the training sessions a final evaluation will again be done. From these measurements any change in physiologic parameters will be noted. The subjects will be asked for a subjective physical status evaluation and for an estimate of work capacity for vocational and recreational activities.

University of Colorado

FINDINGS TO DATE: Five subjects have been entered into the study. Those with ejection fraction less than 25% have all done poorly. Those with ejection fraction over 25% have improved both rest and exercise ejection fraction.

Some patients with poor left ventricular function can benefit from low level exercise. Patients with ejection fractions less than 25% will not do well from a functional point of view. The general psychosocial trend has, to date, not shown the improvement in attitude, spirits, etc. that is seen in those with high level conditioning. The reason for this is not clear.

APPLICABILITY: If we can show that physical conditioning at appropriate levels is "good treatment" in patients with left ventricular dysfunction, then this information and the guidelines for its application should have broad utilization both in the management of patients in the rehabilitation program at the University of Colorado Medical Center as well as in other institutions and clinics throughout the country.

159 Cardiopulmonary Adjustments to Exercise and Other Stresses

Principal Investigator:	G.F. Filley, M.D.	
Status:	Continuing	
Dates:	May 1977-May 1980	
Cost:	Annual \$43,713 RT Annual \$43,713	Projected Total 120,000 RT % of Annual Total 100%
Annual Report Reference:	#14, Page 158, R-163	

OBJECTIVES:

- To determine in normal subjects and patients with heart and lung disease the ventilatory drive precisely at the onset of exercise and as a function of the severity of steady state exercise.
- To validate the fundamental disequilibrium chemistry believed to underlie the operation of the intrapulmonary reflex system which drives respiration. Methods of chemical validation will include study of disequilibria in shed blood in *in vitro* systems and in the deductions from the mathematical models so far developed to study blood gas disequilibria.
- To measure carbonic anhydrase concentration and its activity in arterial plasma obtained from normal persons and from patients in clinical states associated with arterial hypoxemia.

METHODOLOGY: How respiration adjusts to sudden changes of exercise and is maintained in proportion to the severity of exercise so that arterial P_{O_2} stays constant is not understood even in normal subjects, let alone in those with heart and lung disease. Recently, however, we have obtained evidence that intrapulmonary chemoreception of respiratory gas disequilibria drives ventilation in normal subjects (R-161). Because the methods used to measure this drive are noninvasive, they can be used to test patients with heart and lung disease for their ability to adjust their breathing to the stress of exercise.

Briefly, subjects breathe 100% O_2 from a closed system during exercise, their ventilation and end tidal P_{CO_2} being recorded. From a bag-in-box arrangement, 5-10% CO_2 in N_2 or N_2O is breathed in one breath. The precise form of the inspiratory pattern of that breath is analyzed since this pattern is the most sensitive reflection of respiratory drive.

FINDINGS TO DATE: Progress toward all three objectives has been substantial.

- The respiratory equipment needed to measure the human breath by breath response to CO_2 inhalation and its sudden removal has been improved upon so that now it is possible to deliver CO_2 during the first half or the second half of an inspiration. This was achieved by designing and building a 4-way valve activated by a vacuum line. This operates the valve so silently that the subject is not aware of its closing and opening, and rapid access to a new gas source can be achieved in less than a second.
- Disequilibrium measurements. The acquisition of a rapidly responding miniature pH electrode and Brush recorder and the development of a system whereby a liquid phase (plasma or whole blood) in a thin film covered by a teflon membrane can be suddenly exposed to changed P_{CO_2} or P_{O_2} in a gas phase (system open to gas transfer, as in lungs), and then, a second or so later, placed in a closed system (such that CO_2 and O_2 cannot rapidly leave

or enter the liquid phase, as in the systemic arteries), we have achieved the first of two physical models of pulmonary capillary blood gas exchange. (See Section C (i) for the second model.) Although still in its preliminary stages, the data we have obtained show the following:

c. (i) Carbonic anhydrase activity.

The second physical model of pulmonary gas exchange serves a triple purpose since it can also be used to quantitate the effect of carbonic anhydrase and indeed to assay for the activity of this enzyme in human specimens as small as 0.5 uliters. Briefly the pH stat (Radio-meter) delivers 0.3 M HCl from a 0.25 ml syringe to 2.5 ml of a buffered solution containing the substrate at the level in mixed venous blood (NaHCO_3 0.027 M) as CO_2 is continually driven off in a stream of fine bubbles imitating the role of alveoli in removing CO_2 . The rate of CO_2 removal (HCO_3^- -dehydration) is accurately followed by an exponential curve inscribed by a pen driven by a mechanism attached to the plunger of the 0.25 ml syringe and allows the determination of the kinetic dehydration constant k_{-1} at 38° in the pseudo first order reaction at constant H^+ concentration, (H^+).

$$d(\text{HCO}_3^-)/dt = K_{-1}(\text{H}^+)(\text{HCO}_3^-)/K^1$$

where K^1 is the ionization constant at the ionic strength of the solution (0.127). The value of k_{-1} has seldom been measured at 38° in an uncatalyzed medium resembling plasma and the values vary widely (between 32 and 89 sec^{-1}). Our method yields the very consistent value of 70 sec^{-1} at the two pH values so far used (7.40 and 7.54).

Adding human carbonic anhydrase (20 ul of a 10^{-5} M solution, final concentration 8×10^{-6} M) to the reaction mixture cuts the half time from ~ 60 sec to ~ 15 sec (i.e. increases k_{observed} 4-fold). The kinetic parameters of the enzyme catalyzed reaction (K_m and k_{cat} , the turnover number) are being worked out.

Future addition of red cells to plasma in this system and determining the kinetics of blood gas exchange in a physiological in vitro system will complement the data of the first model.

(ii) Carbonic anhydrase detection by immunologic methods.

Antibody to human carbonic anhydrase C is produced in rabbits by initially administering bilateral subcutaneous injections of a water in oil emulsion containing the enzyme. Booster injections are given on the seventh day. On day 21, a serum sample from the animal is analyzed by double diffusion technique on an agarose plate against known concentrations of the antigen. The formation of a precipitate band between the antigen and antibody wells is indication of antibody-antigen complexes. Specificity of the complex for carbonic anhydrase is shown by incubating the plate in a cobalt sulfate-sodium bicarbonate solution and then developing in dilute ammonium sulfide. A black deposit of cobalt sulfide reveals carbonic anhydrase activity. If antibody titer is not sufficient, the animal is boosted a second time and its serum tested in 7 to 10 days. Once antibody titer is sufficient the animal is bled and the serum stored in small divided aliquots at -20°C .

Two milliliters of venous blood are obtained from normal volunteers and patients with respiratory disease. A double diffusion test on 1.2% agarose slide is run on each plasma sample. From this comparison a concentration is extrapolated for the plasma. The sensitivity of this test has been shown for concentrations of 10^{-7} mm.

- d. With the first step of treadmill exercise, the first inspiratory volume V_i and flow rate V_i' always increase over resting values. In air-breathing man the subsequent 2 to 3 breaths are not consistently different from the first. Not until breath 4-5 do V_i and V_i' begin to increase progressively toward the steady state. This early plateau suggests a constant neurogenic stimulus N on which is superimposed an increasing humoral drive H. If this is so and the single inhalation of CO_2 in N_2O which depresses V_i and V_i' (Fed. Proc. 35, 633, 1976) acts by inhibiting H for that breath, the effect of such an inhalation should be nil on breath 1, $\pm$ on breaths 2-3, but should depress subsequent breaths (by eliminating H) toward the neurogenic level (determined by N). These effects were found in 12 normal non-smoking subjects.

Basically, CO_2 inhalation at the beginning of exercise moves the humoral drive of respiration as exercise continues.

- e. We have found carbonic anhydrase (CA) in uncontaminated human plasma (UHP) i.e., separated from untraumatized rbc, in some but not all alveolar epithelial and pulmonary capillary endothelial cells and in respiratory tissues of mouse, trout, frog and snake by (a) potentiometric, (b) immunologic and/or (c) electron microscopic (EM) methods. (1) The pit of buffers placed between the glass surface of a Severinghaus electrode and its

membrane rises so long as the membrane is exposed to P_{CO_2} lower than in buffer (open system) at a rate proportional to buffer (CA); this rate was increased in UHP in all of 30 normal subjects and returned to buffer control with diamox. Lack of rbc trauma was demonstrated by plasma (Hb) analysis (benzidine). The subsequent slow pH fall with system closure (Fed. Proc. 24, 48, 1978) was always present with EM-confirmed CA-containing tissues and disappeared with diamox. (2) Antibodies to human CA isozymes have been used to detect CA by double-diffusion and 2-dimensional electroimmunodiffusion methods and for EM study. (3) EM results of human lung biopsy and animal tissue localization studies show that CA isoenzymes are found intracellularly as well as being associated with the plasmalemma.

APPLICABILITY: Planning of an exercise regimen for patients with cardiopulmonary disease requires knowledge of the special limitation to which these patients are subject. Thus their ability to deliver adequate O_2 to their tissues following sudden exercise demands may be impaired, as recently shown by Auchincloss et al. (1976). The present investigation seems essential to the study of how such patients adjust to transient unsteady states of exercise and should help in planning rational and safe exercise programs for this type of treatment.

160 The Effect of Propranolol on the Conditioning Response in Normal Men

Principal Investigator:	David L. Sable, M.D.	
Status:	Continuing	
Dates:	September 1978-September 1979	
Cost:	Annual \$27,218 RT Annual \$24,218	Projected Total \$27,218 RT % of Annual Total 88%
Annual Report Reference:	#14, Page 143, R-164	

OBJECTIVES: To determine the effect, if any, of beta-adrenergic blockade on the response to aerobic conditioning in normal men.

METHODOLOGY: A total of 12 male subjects, 6 controls and 6 individuals to be given propranolol, will be included in the study. Subjects will be drawn from the UCHSC population between the ages of 21 and 35, will have no history of heart disease, and will have normal physical examinations, electrocardiograms and chest x-rays.

A thorough history and physical examination will be conducted. Data will be recorded on the computer history, physical and stress evaluation form used in the RT Center.

In the preconditioning period, the subject will undergo two baseline exercise stress evaluations using a Quinton motor driven treadmill, Model 18-49e. Data from the second evaluation will be used for baseline observations. Blood levels will be drawn for propranolol, hemoglobin and hematocrit. A maximum of 20 cc of blood will be required on each of 5 occasions during the study.

Pulmonary function testing will include routine spirometry and flow studies. Echocardiography to determine left ventricular function (LV dimensions, ejection, fraction, contractility, indices) will be performed at rest, during and immediately following maximal isometric exercise.

Exercise evaluations will measure heart rate, blood pressure, 12-lead electrocardiogram (emphasizing R-wave amplitude, repolarization changes, rhythm and conduction); the volume of expired air, oxygen consumption, carbon dioxide production; the respiratory rate, the anaerobic threshold, ventilatory equivalents for oxygen and carbon dioxide, oxygen pulse and the oxygen saturation by ear oximetry.

In addition, isometric handgrip exercise testing, and isometric quadriceps exercise testing will be accomplished at each evaluation. Body fat estimates from skinfold measurements will be obtained before and after conditioning.

After the preliminary tests, propranolol will be administered to 6 individuals randomly selected from the 12 subjects. Dose of beta-blockade will be determined by serum levels at two hours post oral administration by methods previously described. A blood level of propranolol of 100 ng/ml or more at 2 hours following an oral dose will be accepted as a level providing a high degree of beta-adrenergic blockade.

Six subjects will receive a placebo indistinguishable in appearance from the test preparation. Blood samples will be drawn from these individuals as well. The study will follow a double-blind parallel design.

During the preconditioning period, with the subjects on effective beta-blockade, repeat treadmill examination, echocardiogram, isometric stress evaluation, catecholamine response to static and dynamic exercise, spirometry and flow studies as well as blood levels of propranolol will be determined in both groups.

The 6 week conditioning period will involve supervised exercise on devices 3 times per week with telemetry monitoring. The heart rate target will be 75-90% of the maximum heart rate attained. Each subject will be attended by an investigator but will not be monitored except for palpation of the pulse at rest and immediately after peak exercise. Both telemetry monitored and outdoor exercise sessions will last approximately 45 minutes including warm-up and cool-down.

Each exercise stress test will be done at the same time after the propranolol or placebo dose (2-4 hours) to relate the blood levels to the degree of beta-blockade and the possible blunting or change in the conditioning response.

At the end of the conditioning period, repeat exercise testing and repeat of all the parameters listed above will be accomplished. The code will be broken and the drug will be discontinued in the propranolol-treated group. A repeat exercise stress test will be done 72 hours after discontinuance of propranolol and placebo.

FINDINGS TO DATE: None. Subjects have been recruited, had introduction treadmill, control studies, have been randomized, dosed and are now in the conditioning period. The study will be completed December 15, 1979.

APPLICABILITY: The idea is that with many patients with coronary artery disease on beta-blockers and also in conditioning programs, one needs to know if the conditioning response, either central or peripheral, is blunted. If so, these patients need not be exercised which would save dollars. If it is not, then current practice is appropriate and should be continued. There is a need to know if those with increased blood pressure and coronary artery disease respond as do normals.

161 The Effect of Physical Training on Cardio-Respiratory Parameters Following Surgical Correction of Congenital Heart Disease

Principal Investigator:	Robert R. Wolfe, M.D.	
Status:	New	
Dates:	September 1978-September 1981	
Cost:	Annual \$34,367 RT Annual \$27,342	Projected Total \$70,000 RT % of Annual Total 79%
Annual Report Reference:	#14, Page 175, R-15	

OBJECTIVES:

1. To evaluate the functional capacity of pre-vocational youth who have undergone total correction of congenital heart defects.
2. To assess the effect of an aerobic conditioning program on cardiopulmonary measurements following total correction of congenital cardiac defects.

METHODOLOGY: Post-operative exercise testing will be performed on the following candidates: (1) youth age 6 to 18 years, (2) status 1 year post-operative or greater, (3) correlative post-operative or greater, (4) isolated catheterization proven post-operative lesions to include:

- a. left to right shunts: ventricular septal defect, atrial septal defect secundum, patent ductus arteriosus
- b. obstructive lesions: aortic valvular stenosis, pulmonary valvular stenosis, and coarctation of the thoracic aorta

- c. Cyanotic lesions: Tetralogy of Fallot, transposition of the great vessels, and total anomalous venous return.

Informed consent will be obtained. A continuous graded exercise protocol will be performed. The following parameters will be measured: (1) time, (2) heart rate, (3) ventilation (BTPS), (4) VO_2 and $\text{VO}_{2\text{max}}$, (5) VCO_2 , (6) respiratory rate, (7) resting and exercising electrocardiogram, (8) indirect cuff systemic blood pressure, (9) tidal volume, (10) blood pressure, (11) respiratory rate, and (12) respiratory quotient.

The following parameters will be calculated from the above: (1) anaerobic threshold, and (2) O_2 pulse.

The approach to exercise evaluation, exercise prescription writing and physiologic assessment during exercise will be the same as utilized for Steady, Unsteady State Exercise Project (R-9) described elsewhere in this directory.

The pilot group will enter an intensive short term training program. Exercise will be performed under telemetry supervision in the Human Performance Laboratory using exercise devices on non-consecutive days (3 days per week) at an exercise level to attain a heart rate of at least 70%-85% of clearance HR determined at the baseline bicycle study. Conditioning exercise will continue for 8 weeks with a repeat exercise evaluation at 4 weeks to rewrite the exercise prescription. Age specific intervals of alternating exercise and rest will be utilized: age 6 to 9 years - 15 seconds, age 10 to 13 years - 30 seconds, age 14 to 18 years - 1 minute.

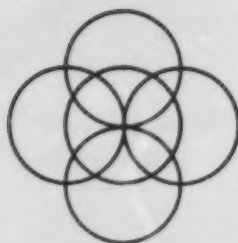
Complete retesting using protocol outlined above will be performed within 3 days of the last conditioning session. If no improvement in $\text{VO}_{2\text{max}}$ or AT is noted, an additional 2 months of conditioning will be recommended. If subjective or objective improvement is noted, a program of home exercise will be recommended. Once the program is functioning in Denver, regional pediatric cardiology training in rehabilitation will be organized in Grand Junction, CO; Fort Collins, CO; Loveland, CO; Casper, WY; Cheyenne, WY; and Billings, MT. It is our intention to formulate the first pediatric cardiac rehabilitation center. In addition to physical conditioning, functions will include psychosocial and career counseling, and guidelines for physical activities in every day life.

FINDINGS TO DATE: 12 post-operative pediatric cardiac patients were tested. Due to the small numbers and diversity of cardiac pathology, conclusions are premature. Within 1 year, 5 patients with early (less than 1 year) Mustard Procedures for complete transposition of the great vessels will be old enough for testing and 10 post-operative Tetralogy of Fallot patients can be tested.

This institution is one of the first to routinely use Mustard Procedure (intra-atrial re-routing with baffle) for complete transposition of the great vessels in the first year of life. As these patients reach an age suitable for bicycle ergometry, they will be tested to establish their functional results. Exercise capacities and lifestyle expectations in this category of patients (commonest form of cyanotic heart disease at birth) are as yet undefined. Other centers (Boston Children's Hosp.) are currently testing late operated patients (after 1 year of age) and it will be important to compare results to establish guidelines for the timing of surgery. Five of these patients can be tested by July 1980.

Tetralogy of Fallot is the commonest form of cyanotic congenital heart disease after the neonatal period. Total correction of Tetralogy often is incomplete. Post-operative exercise performance in these patients has been disappointing. Conditioning effects, however, have not as yet been well investigated. Ten of these patients can be tested, conditioned and retested by July 1980. With the recent acquisition of a full-time Pediatric Rehabilitationist, conditioning and retesting of these individuals can be done. It is anticipated that approximately 50% of all surviving post-operative patients with congenital heart disease will be geographically available and willing to participate in exercise testing and rehabilitation when they reach a feasible age for testing (6 years or greater). (50-75 new patients/year). By 1980, 150 or more pre- and post-operative patients can be tested per year and a significant number of these enrolled in local and regional conditioning and rehabilitation programs.

APPLICABILITY: Youth with congenital heart disease are often considered unlikely candidates for a creative and prolonged life. However, with ever increasing improvements in surgical techniques, the prospects for a full, normal life is steadily improving. There is, however, no comprehensive effort to rehabilitate these youth. This project is an approach toward optimizing care and vocational potential of youth following total correction of congenital cardiac defects.



**University of Wisconsin-Madison (RT-11)
Waisman Center on Mental Retardation and Human Development**

CORE AREAS

Rehabilitation of Families at Risk for Mental Retardation

Comprehensive family rehabilitation which has as its main objective the developmental aspects of retardation with the essential objective of normalizing family units in a variety of community settings that have been, to date, unapproachable utilizing traditional rehabilitation practices. This approach continues to attempt to demonstrate new rehabilitation techniques which will provide a systematic intervention point in ongoing community services delivery systems.

**Rehabilitation of the Adolescent and Young Adult Retarded
with Severe Behavior Deficits**

The rehabilitation process of adolescent and young adult retarded and severely disabled persons with behavioral deficits which can serve as impediments to their effective vocational and/or social adjustment processes. This approach deals with the identification of and programming for severely disabled clients referred for evaluation purposes from active rehabilitation facilities programs.

**Development of Community Alternatives for Severely Disabled
Mentally Retarded Clients**

The investigation of community alternatives with severely disabled retarded clients. In the absence of adequate community services for thousands of mentally retarded clients who have been relocated in a variety of community settings, these research techniques attempt to isolate the needs of these types of clients for habilitation and rehabilitation services. The rehabilitation program, with its current emphasis on the use of community resources in meeting the needs of each rehabilitation client, has the mandated responsibility of providing leadership in developing, implementing and integrating the diverse community services which are necessary to maximize the benefits of deinstitutionalization, both to the client and to society.

UNIVERSITY OF WISCONSIN

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COMPLETED

ABSTRACT NO.

- Independence Training Program for Group Home Residents
(P.J. Flanigan, Ph.D.) 162

CONTINUING

- Establishment of the High-Risk Population Laboratory
(R. Heber, Ph.D., H. Garber, Ph.D.) 163
- Study of the Mentally Retarded At-Risk for Post-Secondary
School Adjustment (formerly: A Longitudinal Study of the
Social, Vocational, Legal and Family Status of Young
Adult Mentally Retarded) (R. Heber, Ph.D., H. Garber, Ph.D.) 164
- Project Deinstitutionalization: Using Extended Evaluation to
Enable Institutionalized Severely Developmentally
Disabled Persons to Demonstrate Their Vocational
Rehabilitation Potential (R. Heber, Ph.D.) 165

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- Survey of Needs of Developmentally Disabled Adults Living in
the State of Wisconsin (P.J. Flanigan, Ph.D.) 166
- Family Rehabilitation Therapy with Significantly Disabled
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TERMINATED

- Crisis Intervention Rehabilitation Applied Research Program for the Severely Developmentally Disabled:
Development of an Extended Evaluation Model
- Strategy Planning to Facilitate the Success of Community Based Programs for the Developmentally
Disabled

162 Independence Training Program for Group Home Residents

Principal Investigator: P.J. Flanigan, Ph.D.
Status: Completed
Dates: October 1977-March 1979
Cost: Annual \$58,585 Projected Total \$50,000
RT Annual \$45,208 RT % of Annual Total 77%
Annual Report Reference: #13, Page 49, R-43

OBJECTIVES:

1. To develop a hierarchy of self help, domestic and community-living skills required to maximize independent functioning of mentally retarded persons living within the community.
2. Preparation and evaluation of an administration manual detailing an instructional program based on sequential training techniques to be used by Daily Living Coordinators working in group homes with mentally retarded persons.

METHODOLOGY:

1. Development of a skill hierarchy through interviews and information collected from standardized adaptive behavior measures completed by 150 group home Daily Living Coordinators.
2. Presentation of an individualized skill hierarchy assessment technology and instructional program methodology for DLCs for evaluation.
3. Revision of the program followed by assessment of the revised product's validity to be established through in-home training and follow-up.

FINDINGS TO DATE:

1. The skill hierarchy and instructional program were completed following group inservice training.
2. Validation of the revised program was conducted.
3. All of the other processes have led to the development of a training manual entitled **Independence Training Program for Group Home Residents** (Outline of Final Training Manual for Group Home Trainers) which includes an Introduction and Rationale for Training Residents in their Home Environment; Profile of Skills - Skills Checklist of Clients' Seven (7) Main Areas of Independent Life Activity; Development of Training Goals and Objectives (What to Train); Program Intervention Strategies (How to Train); Prototypic Training Programs; Self Evaluation for Group Home Training Staff; Advocacy Call (How to Assist Clients in Promoting Self-Advocacy Efforts); and appendices on (1) Characteristics of Developmentally Disabled Clients, and (2) Outline of Service Delivery System for Developmentally Disabled Clients.

APPLICABILITY: Community adjustment of mentally retarded persons requires strong community living skills training. This program will allow the Daily Living Coordinator to use evaluative information to assess skill deficits and implement a training methodology to raise these skills to acceptable levels.

163 Establishment of the High-Risk Population Laboratory

Principal Investigator: Rick Heber, Ph.D.
Howard Garber, Ph.D.
Status: Continuing
Dates: June 1966-March 1979
Cost: Annual \$131,243 Projected Total \$2,110,601
RT Annual \$64,248 RT % of Annual Total 49%
Annual Report Reference: #13, Page 5, R-1

OBJECTIVES: Establishment of a High-Risk Population Category (Milwaukee Project) is a longitudinal study of the prevalence of mental retardation in a depressed urban area and the effects of a comprehensive rehabilitation program in preventing mental retardation.

METHODOLOGY:

1. The high-risk population laboratory was established with the aid of a door-to-door survey conducted in an area of metropolitan Milwaukee which had been previously identified as having an extremely high prevalence of retardation.
2. All members of the survey family, both children and adults, received an individual intellectual appraisal in addition to receiving several experimental learning and language tests. In addition, extensive data was obtained on family, social, education, and occupational history and status.
3. From this population pool samples are selected with the characteristics required by the individual studies being undertaken by the "high risk" population laboratory.
4. The population laboratory survey, over a period of a year, contacted all women residents in the area at the time of child birth. All family members were subsequently individually evaluated when the mother was suspected of retardation on the basis of post delivery intellectual screening. This has made accessible a substantial number of mentally retarded young adults and their offspring.

FINDINGS TO DATE: The data derived from the project during the current grant period further extends previously reported data which indicated that the high prevalence of mental retardation found among disadvantaged population groups is accounted for, largely, by relatively small proportions of the population involved. (This research approach was initially established as a unique focus of the research program of the Center when little knowledge was available about the relationship of poverty to mental retardation.) Based upon this accumulated data, results show that the use of comprehensive rehabilitation of high risk families, families with a high prevalence of mental retardation, must be deemed a successful approach to the prevention of mental retardation.

Families have been followed for over ten years. The children of the treated group show no retardation and in fact no child at ten has an IQ below 85, compared to the control where 60 percent are below 85. In addition, twice as many untreated children are in special classes and/or receive special services than the treated group. A final report of this study is now being prepared.

APPLICABILITY: Comprehensive family rehabilitation when used as an early intervention technique can effectively prevent mental retardation in high-risk children, and can effect positive improvement in life skills of other members of the family.

In addition, the results of this study seriously question present policy with respect to the allocation of social services to population groups. Where epidemiological and process variables are ignored and only demographic variation between groups is the basis for determining resource allocation the delivery of health and social services are doomed to be ineffective and inefficient.

164 Study of the Mentally Retarded At-Risk for Post-Secondary School Adjustment (formerly: A Longitudinal Study of the Social, Vocational, Legal and Family Status of Young Adult Mentally Retarded)

Principal Investigators:

Rick Heber, Ph.D.
Howard Garber, Ph.D.

Status:

Continuing

Dates:

April 1975-March 1981

Cost:

Annual \$78,107
RT Annual \$31,737

Projected Total Not Specified
RT % of Annual Total 41%

Annual Report Reference:

#13, Page 32, R-41

OBJECTIVES: The question remains as to what can be done to reduce this problem. It would first be necessary to develop detailed information about this population of retarded adolescents and

young adults. We need to know who they are, the nature of their social and educational development, the characteristics of their family etc., and most importantly the factors which lead to social and legal difficulties and vocational inadequacy. Subsequently, a program of ameliorative action would be implemented and tested. The program would attempt to intervene in these individuals' lives in order to effectively minimize or prevent the development and manifestation of serious problems of adjustment.

METHODOLOGY: The implementation of this study first requires the identification of such individuals. Cooperation of the public school and local social agencies will be enlisted. A group of adolescents will be identified and closely studied. We will attempt to follow them upon termination of schooling for at least two years to determine the factors influencing social, vocational, emotional, legal and family problems.

Subsequently (i.e., subsequent to identification but prior to the two year study) we will divide the group into two comparable groups in order to test the effectiveness of our intervention program. One group will remain untreated and only observed for comparison purposes to our treated group. The program of intervention for the treated group will test a variety of approaches to prevent the occurrence of these difficulties, such as through (1) crisis intervention, (2) continuing supportive guidance, (3) environment manipulation, and (4) adult education.

FINDINGS TO DATE: During the past year we continued to work at three levels: (1) continuing our epidemiological survey of the adolescent retarded; (2) developing assessment instrumentation for determining client status; and (3) an assessment of attitude and awareness of the retarded in the community.

Presently five school systems are cooperating with our research efforts. These five school systems are located in small urban and rural areas in four counties including Columbia County, Jefferson County, and Dane County. We are studying a population of 57 EMR students presently enrolled in special education classes and 119 who have graduated from special education classes over a six year period.

One major aspect of our current work has been the response by special education personnel and their administrators. While they have themselves felt the urgency of the problems post-school adjustment, they have been unable to coordinate follow-up programs and services for their students.

Assessment procedures follow identification and will include measures of EMR students, their family, community agencies and school personnel. These measures include literacy, attitude, job interest, IQ, etc. Letters explaining the study are being sent to all of the nearly 200 students and their families to be followed by personal telephone contacts to confirm their participation in this study.

APPLICABILITY: The result of this research will provide an understanding of the life process of the high-risk adolescent and young adult retarded. By understanding the characteristics of these individuals it should be possible to selectively identify those in need, the nature of their need and the kind of rehabilitation therapy with which to intervene. Ultimately this work will lead to the prevention of adjustment problems facilitating job placement and to developing social and recreational skills. In addition, this research represents a downward extension of our concern for the family at risk. It is presumed that the target population of this study contains a large number of individuals who will become parents at risk. This procedure then would increase the effectiveness and efficiency of preventive rehabilitation programming.

165 Project Deinstitutionalization: Using Extended Evaluation to Enable Institutionalized Severely Developmentally Disabled Persons to Demonstrate Their Vocational Rehabilitation Potential

Principal Investigator:	Rick Heber, Ph.D.
Status:	Continuing
Dates:	October 1978-September 1981

Cost:	Annual Not Specified	Projected Total Not Specified
	RT Annual Not Specified	RT % of Annual Total Not Specified
Annual Report Reference:	#13, Page 109, R-46	

OBJECTIVES:

1. To determine if institutionalized severely/profoundly retarded adults can adjust to the requirements of a community based sheltered workshop for a full work day, five-day per week schedule.
2. To determine if participation in a community based sheltered workshop has any impact on the client's behavior at the institution.
3. To determine if participation in a community based sheltered workshop will have any impact on the client's work, social, self-help, communication, and leisure-time behavior that is different from what would have been without this involvement.
4. To determine if participation in the project has any influence on the state agency counselor's judgment about a client's feasibility for Vocational Rehabilitation services.
5. To determine if the attitudes toward institutionalized severely/profoundly mentally retarded persons held by Vocational Rehabilitation personnel, of the community based rehabilitation center in which this project occurs, are affected by the participation of such clients.

METHODOLOGY: The research methodology utilized in this project consists of a longitudinal experimental group-control-group repeated measures design. The five program objectives mentioned in the last section provide the parameters within which clinical-research activities will be undertaken. The primary data base consists of the Balthazar Scales of Adaptive Behavior, the Fairview Self-Help and Problem Scales, and direct behavioral assessment.

One of the conditions for client selection was that none of them had ever participated in regular and/or continuing community activities. At the time of their selection, the clients were all living in a large mid-western institution for the developmentally disabled and receiving all of their services on institutional grounds. An additional condition was that all potential clients had to be participating in work activities programs at the institution. In all cases this amounted to approximately one hour per day or less. The only precluding condition for which a client would not be accepted would be if there were complicating medical factors present requiring close and continuing supervision.

From a list of adult residents who met the above conditions five persons were selected to participate as project clients. A comparison group was also selected from the same list on the basis of a close match to project clients. Matching variables used were: Chronological age, sex, intelligence quotient, years in institution, additional handicapping conditions, social age, and behavioral quotient as measured by institutional psychologists.

FINDINGS TO DATE: As a general statement for four out of the five clients it can be unequivocally stated that they were able to adjust to the requirements of the community based sheltered workshop for a full day, five-day per week schedule. Initially each of them did experience some adjustment difficulties ranging from temper tantrums, inappropriate noises, voiding in the wrong places, distractibility, and other behavioral discrepancies between morning and afternoon shifts. These difficulties were at their worst for a period averaging approximately six to eight weeks per client after which noticeable improvements began occurring. The most money, and the importance of this in terms of purchasing power, e.g., the food, drinks, and special privileges that were made available for the money. It was evident that once the relationship between the money and its value was established behavioral improvement began occurring.

Of particular interest were the valuable roles played by many of the other workshop clients who served as teachers and helpers for the project clients. Forms of help varied from personal escort services for two of the clients who were blind; to volunteer enrollment by one person in a signing class so she could learn to communicate with one of the project clients who was deaf; to verbal coaching for good work behavior; and to verbal reprimand for unacceptable behavior. Another interesting finding was the problem behaviors among several of the other clients at the workshop decreased with the appearance of the "new" clients.

Participation in the community workshop had no apparent impact on the client's behavior at

the institution which appeared to remain the same throughout the duration of the first project year. Thus, in spite of recognized clinical improvement in four out of five clients during the work day, no improvements were detected at the institution. During unstructured times, with the exception of eating, all behaviors measured suggested that the project group was indistinguishable from the comparison group while at the institution.

At the time of this writing, no client in the project achieved a level of productivity compatible with acceptance by Vocational Rehabilitation. The production rates of the project clients, based on a full work day, varied from approximately eight percent of competitive norms to an average of approximately thirty percent for the remaining clients. One client achieved fifty percent of competitive norms on several occasions but has not been able to sustain this level for more than a few days at a time. One of the optimistic notes, relative to client feasibility for vocational rehabilitation services, is that although none of the clients has yet achieved the feasibility objective, four out of five clients have shown continuing progress and improvement in their production, quality of work, and time on-task.

When shifts in attitudes of the staff occurred they were always in the direction of moving from a positive attitude to a less positive attitude. Shifts in attitude from an original negative or less positive attitude to one that was more positive never occurred. Why these attitude shifts occurred is difficult to explain, however, one interpretation that may have some merit is that the differences could be due to the contrast between the staff's unquestioned philosophical acceptance of certain popular concepts such as "deinstitutionalization," "normalization," "mainstreaming," etc., and their actual exposure to the realities involved in the implementation of these concepts.

APPLICABILITY: There are many ways in which this research is viewed as being applicable to rehabilitation. On one level, vocational rehabilitation services for the mentally retarded have generally not been directed at those persons either residing or recently discharged from state institutions. Presently used vocational rehabilitation practices and procedures that rely heavily on verbal therapies in a traditional medical model orientation are simply not that effective for dealing with the range and severity of the problems presented by this severely handicapped group of individuals. Yet, with the passage of the Rehabilitation Act of 1973 and the passage of the Rehabilitation Amendments of 1978, Congress has made it clear that vocational rehabilitation services will be prioritized to include the more severely handicapped. In addition, now that independent living has been added to the new provisions, it is both timely and appropriate that relevant data and potentially viable service models be examined closely.

Through this project a provision of the vocational rehabilitation process that is rarely used, namely, extended evaluation, is being examined for its utility in serving and identifying potential rehabilitation candidates from an "institutionalized" population of severely/profoundly retarded persons. The innovative nature of this project is to develop a methodology of extended evaluation in which deinstitutionalization becomes a transitional planned process rather than one that is abrupt and often capricious. Perhaps through community based sheltered workshops and work activity programs where clients are sponsored by their state vocational rehabilitation agencies it may be possible to facilitate an institutionalized individual's adjustment to community life.

At present, the primary focus in most deinstitutionalization efforts is first on the living arrangements followed by a secondary focus on a day program. In this project the central focus has been on the work activity component followed by the identification of living arrangements once an adjustment to the work program has occurred. Many persons now living in institutional settings simply lack the basic pre-requisite skills essential for working and living in the community. Through the provision of an extended evaluation, within which efforts are made to develop these basic pre-requisite skills, the state vocational rehabilitation agency may be able to play an extremely important role with this heretofore unserved population while simultaneously contributing to national deinstitutionalization efforts.

It has been estimated that it costs between \$75 and \$85 per day for a mentally retarded person to live in a state institution. Although exact costs are presently unavailable it would not be unrealistic to expect this amount to be reduced by as much as half if the person lived and worked in the community. In terms of cost analysis benefits alone there is more than ample justification in tax dollar savings to warrant vocational rehabilitation's involvement with this severely handicapped institutionalized population.

166 Survey of Needs of Developmentally Disabled Adults Living in a Variety of Community Settings in the State of Wisconsin

Principal Investigator: Patrick J. Flanagan, Ph.D.
Status: Continuing
Dates: September 1978-September 1979
Cost: Annual \$28,466 Projected Total \$38,500
RT Annual Not Specified RT % of Annual Total Not Specified
Annual Report Reference: #13, Page 13, R-48

OBJECTIVES: "Survey of Needs of Non-Institutionalized Developmentally Disabled Adults" is a continuing research project at RT-11 which has as its principal objective initiating a Needs Assessment Survey of a sample of approximately 400 severely developmentally disabled adults living in a variety of community settings in various locations across the state of Wisconsin. The project, which is in its 3rd year, has as its major outcome the compilation of these survey data to provide information and needs of the severely developmentally disabled adult in community settings and the degree to which our present legal and administrative provisions meet these needs.

METHODOLOGY: Samples of severely developmentally disabled adults ranging in chronological age from 18 to 50 were drawn so as to be reasonably representative in terms of proper size, economic well-being, urban-rural settings and other economic variables in the state of Wisconsin. Specially trained interviewers conducted individual sessions with each client in the sample. In preparation for administration of the Needs Assessment Survey interviewers were trained in all aspects of the investigation, as well as the techniques of interviewing. In addition to interviewing the subjects in the study, professional individuals serving in programs and services in the community level; especially near the residential facilities housing the clients, also provided data regarding the vocational adjustment of the clients in the community. The basic set of adjustment indices developed in the survey were designed to infer the unmet needs of the clients and included employment and financial security, social adaptation, community mobility and leisure time. The accessible segment of the severely developmentally disabled population proved to be those severely developmentally disabled adults who were (1) recently deinstitutionalized, (2) living in group homes, sheltered apartments, and intermediate care facilities, and (3) those clients in contact with a state agency such as the Department of Vocational Rehabilitation.

FINDINGS TO DATE: During the final phases of the project the results of the Needs Assessment Survey will be analyzed in comparison to several sets of legal, administrative and attitudinal variables. The final analysis will attempt to define those areas in which severely developmentally disabled adults have necessary but unmet community needs as well as attempting to identify, in concert with the appropriate state agencies, where conditions could be modified in order to better meet the needs of the severely developmentally disabled adults.

APPLICABILITY: Not applicable.

167 Family Rehabilitation Therapy with Significantly Disabled Parents

Principal Investigators: Rick Heber, Ph.D.
Howard Garber, Ph.D.
Status: New
Dates: June 1979-March 1982
Cost: Annual \$134,050 Projected Total \$402,150
RT Annual \$70,150 RT % of Annual Total 52%
Annual Report Reference: #13, Page 135, R-47

OBJECTIVES: This research project is designed to provide rehabilitation for parents and children from significantly disabled families. While concentrating on home situations in which the parents or principal caretakers are severely disabled and/or mentally retarded, the intervention treatment

will be directed toward improving each family's ability to mediate life's daily experiences. We view family therapy to be a comprehensive rehabilitation program which includes vocational and job counseling, parent training and child care advice, remedial academic education and home management training, family counseling, motivational training, and advocacy and community liaison services. This constellation of services is designed to help parents to deal with employment difficulties, to train parents to work more effectively with their children, and to encourage parents to interact more effectively with their personal social world in and out of the home. By providing therapeutic family rehabilitation, we intend (1) to significantly reduce the tendency for such families to incur disruptive home crises, and (2) to develop new models of family therapy through which parenting skills will be upgraded, and, as a by product of which, parents will be supported in their efforts to promote the skill proficiencies in their children required for adequate growth and social adjustment.

METHODOLOGY: Although most parent training programs are directed toward reducing deficits in life skills, they tend to disregard all but the most superficial family characteristics. Therefore, the key to this study's methodological approach will be our ability to individualize the treatment programs we offer each of our client families. We plan to employ a team of professionals, drawn from different fields, with complementary expertise. Two and three member teams would then go into each home, evaluate the family, observe the interaction among the members, including the strengths and the weaknesses of the family processes, and then, ultimately, prescribe and administer a specific intervention program designed to maximize each family's strengths, and, over time, to minimize detrimental influences.

By approaching the problems of the severely disabled parents with a personalized, comprehensive family rehabilitation therapy, we will derive, as an additional benefit, a typology for the study of factors affecting the acquisition of skills: necessary for the adequate management of daily family life. In particular, our intervention protocol will develop procedures (1) to screen disabled families who are in need of support services, (2) to assess vocational rehabilitation needs and to evaluate the quality of the parenting process (i.e., the complex pattern of personal, familial interrelationships which influence intellectual and emotional growth), (3) to provide, as treatment, training counseling and advocacy services directed toward both upgrading existing family strengths and providing the supplemental skills which our client parents and children will need if they are to meet the many varied responsibilities of their social world both in and out of the home, and (4) to follow client families after the termination of intervention in order to determine which families will require continued and even long-term support services. We would emphasize that this intervention approach of interrelating screening, assessment, treatment and follow-up procedures is both different from past practice and consistent with our analysis that outside (i.e., outside the individual) forces can and do impede positive change after intervention therapy.

FINDINGS TO DATE: A pilot phase of this project has been conducted in a low income rural area of Wisconsin with sixty significantly disabled families. A screening procedure initiated by referrals from social and educational agencies was designed and employed to select these significantly disabled families from the general population residing in these areas. Families selected were those with parents of low intellectual and academic skills who also evidenced problems conducting independent family life (e.g., one or more parents unemployed, one or more children in special education classes, and evidence of one or more social problems—alcoholism, child neglect-abuse). This initial screening revealed that these families indeed present a wide array of vocational, academic and social needs, presently not being served by the community.

The second phase of the pilot project was aimed at specifically identifying the treatment needs of these families. An assessment procedure was designed and implemented focusing on the family processes that appear to be influencing and/or contributing to the families inability to maintain an efficient and independent family unit. Parental, particularly mothering skills, were assessed. Children's academic, intellectual and problem-solving skills were measured. From this assessment phase a picture is emerging that these severely disabled families are ineffectual in their parenting skills and are actually employing processes that are detrimental to normal family life and specifically detrimental to the children's intellectual, language, academic, and motivational skills.

As a follow-up to the assessment phase, a six week training program, designed individually for

each of the families was conducted indicating that both the mothers and preschool children can benefit intellectually, academically, and motivationally from basic training in effective parenting skills.

Fourth, and probably of ultimately greatest significance was the effect on these families of providing them with basic advocacy services. Channels were developed between these families and appropriate social and educational services in the community. Parents who were reluctant and in some cases fearful to meet with these agencies were aided in meeting with and obtaining required services. Families were given information about and actually helped to receive needed social services such as welfare supplementals, medicaid, food stamps, and vocational rehabilitation services.

From this pilot phase, it appears that a large number of severely disabled families exist and that these families present a wide range of social, academic, and vocational rehabilitation needs. Furthermore, these families do not have the basic skills required to advocate for themselves in acquiring these services. As McClug (1975) emphasizes, "Experience shows that while middle-class parents often assert legal rights, handicapped children from low-income families often suffer disproportionate exclusion, misclassification and miseducation because parents are not aware of their rights or of how to enforce them."

In severely disabled families, families which are not only low-income, but where also one or more of the parents are retarded evidence even a more crucial need for advocacy services. These families not only do not know their rights, but are intimidated by and fearful of the complex social service delivery system which provide the services these families badly need.

APPLICABILITY: Current rehabilitation practice bases its treatment options on a monolithic conception of at risk families who are seen as being identical with respect to both the daily problems they face, and the remediation they need. Such a view of the disabled masks individual differences in the nature, the quality and the quantity of the retarded handicap. Specifically, this lack of understanding leads to problems in planning vocational programs which confound delivery since the system has no model options. We need program planning which adopts the view that people are vulnerable to maladjustment when they lack specific skills needed to resolve personal problems (Cowen, 1977). And we need a delivery system which identifies those skills, and imparts them early enough in life so that maladaptive behaviors have not begun (Garber and Heber, 1970). The thrust of this approach is educational, not restorative, and individualized, not mass causality, oriented (Stone, Hinds & Schmidt, 1975).



**University of Arkansas (RT-13)
Vocational Rehabilitation Research and Training Center**

CORE AREAS

Rehabilitation Counseling

The discovery and development of knowledge and skills resulting in greater effectiveness of rehabilitation counselors as helpers with clients demonstrating psychological and vocational difficulties.

Psychosocial Treatment Strategies

The discovery and development of psychosocial treatment programs specifically for use by rehabilitation practitioners with clients and modified existing treatment programs for the special needs of rehabilitation settings or specific rehabilitation populations.

Program Evaluation

The discovery and development of procedures and techniques for systematically evaluating the effects of rehabilitation services on client adjustment.

UNIVERSITY OF ARKANSAS

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COMPLETED

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168 Development and Evaluation of a Self-Instructional Physical Fitness Training Program for Spinal Cord Injured Rehabilitation Clients

Principal Investigator: G. Tim Milligan, M.S.E.
 Status: Completed
 Dates: October 1975-October 1978
 Cost: Annual \$9,198 Projected Total \$24,000
 RT Annual \$5,886 RT % of Annual Total 64%
 Annual Report Reference: #14, Page 158, R-145

OBJECTIVES: To develop an individualized self-instructional physical fitness training program for use of rehabilitation clients with paraplegic involvement.

METHODOLOGY: This program was conducted in two phases, a program development phase and a program evaluation phase.

A self-instructional physical fitness program to increase trainee functioning in exercise, hygiene, rest, and diet behavior was constructed. Rehabilitation physicians, occupational therapists and physical therapists provided input for materials and methods.

The program was evaluated by measuring the effect of the program of a group of 10 persons with paraplegic involvement.

Subjects were given a preliminary fitness evaluation and requested to read the program materials. Use of the materials was optimal.

The program was evaluated in terms of: (1) likelihood of use by paraplegics; and (2) fitness changes for those who used the program compared to those who did not use the program.

FINDINGS TO DATE: Results of Fitness Evaluation:

Subject	Self-initiated Participation in Program	Flexibility (Scale of 1 to 4)			Endurance (Scale of 0 to 100)		
		Pre	Post	Change	Pre	Post	Change
1	Regular	4	4	0	20	40	++++
2	Very little	1	2	+	15	20	+
3	Very little	4	4	0	10	10	0
4	Regular	4	4	0	15	35	++++
5	Regular	4	4	0	15	30	+++
6	Very little	1	1	0	15	20	+
7	Very little	4	4	0	10	10	0
8	Very little	4	4	0	20	20	0
9	Some	4	4	0	15	20	+
10	Very little	4	4	0	10	10	0

Subjects reported almost no change in flexibility as a result of the program. However, the explanation lies more in the high levels of initial flexibility of these clients than in failure of the program.

Although still functioning at very low levels of endurance, subjects did improve in this area as a function of use of the package.

APPLICABILITY: This program provides fitness training materials to increase the physical functioning of persons with paraplegic involvement. Hopefully, it will result in a shorter rehabilitation time and decreased incidence of physical losses following termination of formal services.

169 A Survey of Client Perceptions of the Service Delivery Systems of a Comprehensive Rehabilitation Center

Principal Investigator: Richard Roessler, Ph.D.
Status: Completed
Dates: August 1977-March 1979
Cost: Annual \$34,496 Projected Total \$50,000
RT Annual \$22,076 RT % of Annual Total 64%
Annual Report Reference: #14, Page 209, R-152

OBJECTIVES:

1. To identify problems that rehabilitation clients face at a comprehensive rehabilitation facility
 - a. How do clients respond to these problems?
 - b. How could they respond more competently?
 - c. What additional training needs are suggested?
2. To measure client perceptions of the facility environment
 - a. Is the environment perceived to be therapeutic?
 - b. Is the environment perceived differently at different stages of a client's stay?
 - c. What recommendations of a programmatic nature can be made to strengthen the therapeutic nature of the Center's environment?
3. To assess client satisfaction with facility services
 - a. Are clients satisfied with facility services?
 - b. What are the strengths and weaknesses in the facility's program from the client's point of view?
 - c. What suggestions can be made to strengthen the Center's service program?

METHODOLOGY: Analysis of Behavioral Competence Areas for the Disabled Client: The identification of behavioral competencies needed by disabled clients is based on an analysis of the behavior/environment interactions of disabled clients at the Hot Springs Rehabilitation Center. The procedure emphasizes identifying problematic situations and the variety of responses, ineffective to effective, for each of the problematic situations. Information from the study will help Hot Springs Rehabilitation Center staff identify problems experienced by disabled clients and ways for helping the clients respond competently to the problem situations.

Analysis of Social Climate: Using Moos' Community-Oriented Program Scale, client perceptions of the environment of the Hot Springs Rehabilitation Center were assessed. The scale provides insights into several dimensions of the Center's environment: relationships, treatment program aspects, and system maintenance and change.

Service rating: As part of the client survey, a rating form for services offered by the Hot Springs Rehabilitation Center was also completed by severely disabled students. The rating form listed the various service areas of the Center and enabled each respondent to indicate where the service fell in a range of responses from excellent to failure.

The purpose of the service rating is to indicate the extent to which clients perceive Center services as effective. Data from the service rating can be related to other instruments in the client survey.

Sample: A random sample of new and experienced rehabilitation clients at the Hot Springs Rehabilitation Center was included in the study. Each client group was interviewed twice; the new students, at entry and three to four months later; and the experienced students, after three months and six months tenure in the Center.

FINDINGS TO DATE: The results of the student real-ideal comparisons revealed that the students wish their environment to be changed in the same general way as the staff. Both staff and students desire a Center environment characterized by (a) considerably higher levels on the relationship dimensions (more student involvement in the program, more staff support for students and student support for each other, and more free and open expression within all relationships) and (b) more

order, organization, and program clarity than currently exists.

Students enrolled for a relatively short time perceived the environment in the same way as students enrolled for an average of four months. Although staff real perceptions changed over the duration of the interviews, students' real perceptions remained the same from one interviewing phase to another. Perhaps the changes which were being perceived by staff did not affect the students or had not yet been recognized by the students. Interestingly, the results of the assessment of the Center environment reveal exceptional similarity between staff and student perceptions of desired directions for change toward an environment which is more relationship-oriented, more orderly, and more organized.

On the average, students reported satisfaction with the various services. Only two of the twenty services (physician services and placement) were rated, on the average, below the mid-point on the seven point scale. Food, dormitory, evaluation and nursing services were rated as satisfactory by 50 to 75 percent of the students which suggested only a moderate level of dissatisfaction in these areas. Placement and physician services were identified as likely having multiple problems (rated as satisfactory by less than 50 percent of the students). However, only a very small number of students had received placement services, and these ratings did increase when students were interviewed the second time. Students who were successfully placed were not included in the sample surveyed for this study.

In the survey of student problems, both new and experienced students reported approximately two to three problems in the first interview. By the second interview, the number of problems reported by the two groups dropped to an average of about one problem per student. Generally, students were most concerned with problems in the areas of (a) conflicts with other students, (b) regulatory conflicts, (c) medical service problems, and (d) detrimental staff attitudes and behaviors. Data from the students' second interviews revealed fewer problems and less agreement regarding where the problems lie. In the second interview, students were less likely to mention problems with medical services and more likely to mention concerns about vocational training.

Recommendations for practice which resulted from the study included the following:

1. The Center Policy Committee should implement and evaluate a system to increase staff-initiated student contacts. The staff should make every effort to communicate understanding of student problems and concerns, systematically reinforce appropriate student behavior through techniques such as compliments, and handle inappropriate behavior as promptly and systematically as possible.
2. Programs such as peer helping groups and interpersonal skills training should be undertaken to encourage students to be supportive and helpful to each other.
3. House parents and counselors should monitor and encourage student involvement in social and recreational programs at the Center.
4. A collaborative effort by staff and students to review current Center regulations is needed.
5. Student living arrangements should be established emphasizing increased responsibility and independence as a reward for appropriate behavior.
6. Medical services personnel should also emphasize the relationship aspects of their role which involves modeling good communication techniques with students. In addition, increased psychological services are needed in the medical department.
7. A method should be instituted for identifying potential dropouts based on such data as observed conflicts with counselors, staff, and other students, statements such as "no one cares - no one understands," and other information contained in the admissions file which suggests a history of failure prior to coming to the Center.
8. A study of the way in which students use their leisure time at the Center should be undertaken. The purpose of the study would be to identify the avocational needs of the student so that a systematic avocational counseling program could be instituted.

Recommendations from this study as well as from the staff phase of the study (R-154) have served as the basis for a number of study group meetings. The purpose of the study group is to develop alternative implementation strategies, discuss the relative merits of the various strategies, and

select a single strategy to implement in the Center. To date, a number of innovations in Center practice such as an Honor Dormitory, increased evaluation and psychosocial services, a review of the student handbook, etc. have resulted from the study.

APPLICABILITY: A significant phase of this project involved the translation of the problems, environmental perception and service satisfaction data into information pertinent to an administrative review of the Center. The student and staff segments of the study combined yielded over 100 recommendations for changes in Center procedures. In addition, aspects of the student data have also provided insights into areas in which training programs should be developed for disabled students. Finally, the methodology of this survey appears to have considerable potential for application as a review procedure to other comprehensive rehabilitation facilities.

170 Development of a Model for the Analysis of Case Movement in a Vocational Rehabilitation System

Principal Investigator:	Paul Cooper, M.S.	
Status:	Completed	
Dates:	September 1975-June 1978	
Cost:	Annual \$2,300 RT Annual \$1,472	Projected Total \$45,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 355, R-153	

OBJECTIVES: Basic to the efficient operation and management of any rehabilitation system is an accurate understanding of case flow through the system. One technique for achieving this understanding is the development of a precise mathematical description of the system's operation with respect to case movement, i.e., a case movement model. Construction of a viable case movement model could potentially add much to our understanding of the system allowing corresponding increases in control and efficiency. For example, at the present time most rehabilitation agencies would be hard pressed to forecast the demand on training facilities six months from now if the number of cases accepted for services each week was increased by ten percent. A viable case movement model would provide the means for more accurate predictions of this demand. Basically, a case movement model would provide information as to the number of clients expected to be in a given status at a particular time and how long a client is expected to spend in a given status.

The proposed project proceeded in several phases:

Phase I: The investigations reviewed statistical literature in an attempt to identify standard models which might be applicable to case movement in a rehabilitation agency. It was decided to attempt a statistical rather than simulation model. The data needed to construct the model was identified.

Phase II: Data collection procedures were designed and implemented in two Arkansas district offices. An informal evaluation of these procedures was conducted.

Phase III: Based on the data collected in the two district offices, a case movement model was constructed.

Phase IV: Testing and refinement of the model were completed. Results were disseminated through research reports, journal articles and presentations. A project was proposed and initiated to field test the model on a statewide basis and compare it to alternative simulation models.

METHODOLOGY: Statistical literature dealing with stochastic processes (in particular, Markov chains), queuing theory (the study of waiting lines), and operations research was searched for appropriate statistical modes. Additionally, the possibility of a systems simulation approach was investigated. This literature research resulted in the conclusion that a Markov model would be one appropriate technique for describing the movement of cases in a vocational rehabilitation system. The system simulation approach was also judged to be feasible and worth further consideration at a later date.

Predictions of numbers of cases in the various statuses were made and verified by observing actual outcome over time. The model will be continuously refined so that it may be used to predict various system parameters under alternative potential operating conditions.

FINDINGS TO DATE: Severely and nonseverely disabled clients tend to exhibit different case movement characteristics.

1. Severely disabled clients tend to remain longer in referral (status 00), plan completed status (12), physical restoration (status 16), and services interrupted status (24) than their nonseverely disabled counterparts.
2. 68% of the nonseverely disabled clients in the research sample who were eligible for services were closed in competitive employment while only 43% of the eligible severely disabled clients were closed competitively employed.
3. Severely disabled clients are more likely to have services interrupted and from services interrupted have only one chance in four of becoming successfully rehabilitated while nonseverely disabled clients have approximately one chance of three of successful closure.
4. Nonseverely disabled clients are more likely to become successfully rehabilitated than severely disabled clients. Therefore, as the percentage of severely disabled clients increases, the number of successful rehabilitations may be expected to decrease.

The two district offices represented in the research sample showed an increase in the proportion of severely disabled clients from July 1976 to April 1978.

Although it is well known that there are seasonal variations in referral and closure rates, case movement may be viewed as a process independent of the time of year.

Several guidelines for the development of a statewide model have been identified.

1. Case movement modeling should be an ongoing effort.
2. The data collection effort should be integrated into the current client data processing system.
3. Additional emphasis should be placed on the appropriate use of the status system.
4. The severely disabled should be considered separately from the nonseverely disabled in the development of a case movement model.

APPLICABILITY: Continuous program planning and evaluation activities are required by Section 101(a) (15) of the Rehabilitation Act of 1973; Section 401.18 of the Vocational Rehabilitation Regulations; and Chapter 5, Section 6 of the Vocational Rehabilitation Manual. The development of a valid case movement model for the rehabilitation agencies could provide better understanding of case movement, more accurate prediction of future demand on facilities under alternative intervening situations, and better evaluation of changes in the system. Thus such a model is useful in both the planning and evaluation of rehabilitation programs as mandated by Federal regulations to four of the RSA research objectives:

- A. Develop and test new program evaluation tools, techniques and procedures including measures of quality control.
- E. develop improved planning systems.
- F. develop improved management information systems . . .
- G. develop models for improvement in decision making using simulation and content from the VR field."

A case movement model as proposed here will not only provide a framework for the evaluation and monitoring of case flow as required in A and F but will also provide a basis for planning and decision making as required by E and G.

As a residual benefit the collection of time-in-status data will provide data useful for assessing the extent to which the status system is accurately employed by rehabilitation counselors.

171 The Identification of Factors Affecting Behavioral Competency in a Comprehensive Rehabilitation Center

Principal Investigator:	John N. Marr, Ph.D.	
Status:	Completed	
Dates:	August 1976-August 1978	
Cost:	Annual \$11,499 RT Annual \$7,359	Projected Total \$39,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 369, R-154	

OBJECTIVES

1. To identify problems in each service area of the rehabilitation facility.
2. To identify factors which restrict staff in their attempts to cope with the problems.
3. To analyze the problems and factors in terms of relative importance and possibility of resolution.
4. Prepare reports for facility administrators on recommendations and strategies for resolving the behavioral problems.

METHODOLOGY: All sections (except maintenance) of the facility staff were surveyed in an effort to determine (a) the extent to which each service facilitates effective operation of the Center, and (b) extent to which each service contributes to the final objective of the center—preparing the client for employment.

The behavioral assessment method of interviewing clients in behavior therapy was adapted to interviewing 120 staff about problems they experienced while delivering services to students. Each staff member was asked to identify antecedents, behaviors, and consequences of each problem and to further identify their responses to their problems.

A survey was also made of (a) a small sample of field counselors who have referred clients to the Center, to determine their objectives for service delivery when referral was made, and (b) field counselors with recently graduated or terminated clients, to determine their satisfaction with the Center's delivery of services.

FINDINGS TO DATE: Data collection has been completed. Parts I and II of the final report have been prepared for distribution to all Center staff. Findings of the study indicate that the behavior approach of administering a social climate scale and interviewing clients, staff and students yields a comprehensive picture of service delivery which allows administrators and supervisors to assess general morale, strengths and weaknesses of various service sections, and also pinpoints specific changes which need to be made. Over 100 recommendations were made in Part II of the final report and the Center has responded by appointing action teams to implement most of them. Analyses of the relationships among measures indicated that the social climate scale results agreed with the behavioral assessment results in identification of the department with the most severe problems. The former measure was more time efficient but the behavior assessment interviews produced more than 8 times the number of specific recommendations for change. Client interview data was not as productive but did indicate that clients are relatively more passive in responding to problems they experience in service delivery and that those who do not complete programs in the rehabilitation center were less likely to respond effectively to their problems and were less likely to be aware of the outcomes of their responses.

Field counselor interviews were too few to generalize the results to the population who referred clients to the Center but it was recommended that a more complete study of the field counselors be made.

APPLICABILITY: This project was viewed as an applied, action research study to determine factors which affect the efficiency and effectiveness of a comprehensive rehabilitation facility. The possibilities for generalization were limited by the uniqueness of the facility to some extent. However, the results should have some application to similar facilities.

172 Post-Workshop Telecommunication Consultation to Improve Use of Behavior Management Procedures

Principal Investigators: John N. Marr, Ph.D.
Suki Hinman, M.A.

Status: Completed

Dates: November 1977-September 1978

Cost: Annual \$19,164 Projected Total \$25,000
RT Annual \$12,264 RT % of Annual Total 64%

Annual Report Reference: #14, Page 166, R-157

OBJECTIVES: Develop, pilot-test, and refine both paper-and-pencil and direct observation instruments to assess rehabilitation (direct-care) staff knowledge and use of behavior management techniques in home work setting.

Conduct three 3-day workshops on applications of behavior management techniques to rehabilitation for staff from 37 state-funded and community-sponsored Arkansas rehabilitation facilities, evaluate immediate effectiveness and consumer satisfaction.

Test the relative effectiveness of two modes of additional training in increasing (post-workshop) use of behavior management techniques by operating a behavioral consulting service by mail for all participating agencies for a total of 16 weeks, and by providing weekly telephone consultation to selected subsamples (for 8 or 16 weeks).

Provide behavioral consultation by mail during an 8-week extension period after completion of the main investigation as an additional service to participating agencies.

Prepare reports concerning effectiveness of these strategies and recommendations for applications to training in other areas; disseminate findings (refined instruments, procedures, results) to other rehabilitation agencies/facilities.

METHODOLOGY: During Phase I a paper-and-pencil instrument to assess current level of knowledge and utilization of behavior management procedures was developed and refined. A relatively unobtrusive observational scheme was developed to validate the paper-and-pencil self-report.

The mail and telephone survey of 55 agencies providing rehabilitation services to handicapped clients in Arkansas resulted in 37 agencies participating in the project. They were assigned to seven groups. During Phase II an introduction of two independent variables (workshop, telephone) at three different points in time was accomplished via a seven-group multiple-baseline design. The basic research design was conceptualized in terms of one tri-level factor (weekly telephone calls for 0, 8, or 16 weeks), combined with an all-or-none application of the second treatment (presentation of workshop knowledge) in a chronologically staggered fashion. In addition, all groups had access to the mail consultation service throughout the study and for seven weeks following the last workshop and the end of the weekly telephone call.

Two staff members from each agency attended 3-day workshops at the beginning, middle, or end of the study. Workshops consisted of lectures and practice-to-criterion sessions on correct use of behavior modification techniques to teach new skills and manage behavior problems. In a consultation request, the agency staff specified the behavioral problem antecedents of the behavior, consequences, and client and agency limitations to treatments. After a project staff meeting, measurement methods and treatment alternatives were specified in writing to the requesting agencies. Requests used codes to protect clients identity and each request was answered within 48 hours.

Self-report data on utilization of specific behavioral management techniques was collected at 0, 9, and 18 weeks. A sample of agencies was visited during those same weeks to collect observational data on utilization. In addition, two raters visited each of the agencies at 27 weeks to independently rate correct utilization of programs designed in response to consultation requests.

FINDINGS TO DATE:

1. Agencies liked the consultation service and rated the workshops as excellent.

2. Weekly telephone calls clearly had an effect on use of the mail consultation service. Of those agencies receiving calls, 85% used the service as compared to 30% of the agencies not receiving calls.
3. The short-term workshops only had a slight effect on consultation requests made, but did effect reported utilization of procedures, and correct use of procedures.
4. A total of 97 consultation requests were received and more than 150 treatment programs were written in response to the problems described. These will be collected and published as a reference for rehabilitation professionals.
5. Consultation by mail with telephone contact is a procedure that can help improve services but this study found that treatment programs could be written with greater confidence as the consultants became more familiar with agency physical layout, staff schedules, and client programs within the agency.

APPLICABILITY: Previous studies had found that over 70,000 man-hours were expended in 1975 by rehabilitation professionals in in-service training and that the techniques taught in workshops are utilized relatively seldom in home work settings. This study indicates that mail consultation and WATS telephone contacts are methods of increasing the utilization of new techniques introduced through short-term workshops.

173 The Impact of Facilitative Case Management Training on Rehabilitation Counselor Behavior

Principal Investigator:	Roy C. Farley, Ed.D.	
Status:	Completed	
Dates:	March 1976-October 1978	
Cost:	Annual \$13,031 RT Annual \$8,339	Projected Total \$37,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 77, B-161	

OBJECTIVES: The purpose of this study was to evaluate the Facilitative Case Management training package. General objectives included: to demonstrate the effectiveness of the program and to identify its strengths and weaknesses so that an expansion and refinement of the program can be done if the results indicate the need. Specific objectives were as follows:

1. To determine the effect of FCM training on rehabilitation counselors' acquisition of basic principles and concepts about rehabilitation case management.
2. To determine the effect of FCM training on rehabilitation counselors' knowledge of how to distinguish a facilitative response from a nonfacilitative response.
3. To determine the effect of FCM training on rehabilitation counselors' knowledge about how to distinguish between the effects of different moment-to-moment interaction techniques.
4. To determine the effect of FCM training on rehabilitation counselors' overall cognitive development.
5. To determine rehabilitation counselors' overall reaction to FCM training.
6. To determine counselors' reaction to the program's content in terms of its value, appropriateness, and practicality.
7. To determine rehabilitation counselors' reaction to the organization of the training program and its stimulation, interest, and balance of activities.
8. To determine the effect of FCM training on rehabilitation counselors' information-collection behavior during the initial interview.
9. To determine the effect of FCM training on rehabilitation counselors' information-dissemination behavior during the initial interview.

10. To determine the effect of FCM training on rehabilitation counselors' interaction style during the initial interview.
11. To determine the effect of FCM training on rehabilitation counselors' level of empathic understanding during the initial interview.

METHODOLOGY:

1. The basic research design that was used to evaluate the FCM training program was the pre-test/post-test control-group design.
2. The sample was vocational rehabilitation counselors employed by state vocational rehabilitation agency.
3. The independent variable was FCM training.
4. The dependent variables related to the eleven specific objectives listed in previous section.
5. Instruments were developed and/or adapted to measure each of the eleven dependent variables.
6. Experimental procedures consisted of the following:
 - a. random assignment of subjects in the sample to an experimental group or control group.
 - b. collection of a tape recorded initial interview and pre-testing of each subject.
 - c. Facilitative Case Management training provided to the experimental group.
 - d. collection of another tape-recorded initial interview and post-testing of each subject.
 - e. tape raters were recruited and trained to rate each tape on the appropriate dimensions.
 - f. results were analyzed by appropriate statistical procedures to determine if there was any significant difference between the experimental and control groups on each of the eleven dependent variables.

FINDINGS TO DATE:

1. FCM training has a positive impact on the following dependent variables:
 - a. knowledge about basic principles and concepts of effective case-management procedures
 - b. knowledge about how to distinguish a facilitative response from a nonfacilitative response
 - c. knowledge about how to distinguish between the effects of different moment-to-moment interaction techniques
 - d. overall cognitive gain
 - e. counselor's general feelings and attitudes toward FCM training
 - f. counselor's feelings and attitudes toward the organization, content, and balance of activities in FCM training
 - g. counselor's feelings and attitudes toward the value, appropriateness, and practicality of FCM training
 - h. counselor's information-collection behavior
 - i. counselor's information-dissemination behavior
 - j. counselor's ability to communicate empathic understanding
2. FCM training had no impact on the following dependent variable: counselor moment-to-moment response style.

APPLICABILITY: The findings in this study will be used by rehabilitation agency staff development trainers, rehabilitation counselor educators, and rehabilitation counselor supervisors as documentation of the effects of FCM training. The research reports will serve as supplemental training material for

those responsible for training rehabilitation counselors and rehabilitation counselor students in FCM.

The findings will also be utilized for the continued expansion and refinement of the FCM training program.

When a training program is revised, upon what can the revisions be based if not the results of the original program. The areas of weaknesses discovered in this study will be strengthened and the strong areas reinforced in the revised FCM programs.

174 Client Motivation in Rehabilitation

Principal Investigator:	Brian Bolton, Ph.D.	
Status:	Completed	
Dates:	October 1976-December 1977	
Cost:	Annual \$1,533 RT Annual \$981	Projected Total \$7,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 178, R-162	

OBJECTIVES: This investigation included the following activities:

1. review of the experimental and theoretical literature pertaining to client motivation;
2. preliminary analyses of objective test data, including several motivational variables; and
3. a programmatic investigation of the motivational dynamics of 205 female rehabilitation clients.

METHODOLOGY: The research sample for this project consisted of 205 disadvantaged females who were participants in the Public Assistance Project conducted at the Hot Springs Rehabilitation Center between 1968 and 1972. Descriptive characteristics of the sample are as follows: 68% welfare recipients, 57% black, 49% high school graduates, median age of 24, and median IQ of 92. All subjects completed a battery of inventories that were selected to assess relevant aspects of client motivation for rehabilitation. In addition, a structured interview was completed with each client in which demographic data and information pertaining to values, preferences, and activities were obtained. Data analyses included normative and subgroup comparisons, factor analyses, and bivariate and multiple correlation analyses.

FINDINGS TO DATE: The major findings of the investigation were as follows:

1. In comparison to population norms, the sample of disadvantaged females exhibited lower self-esteem and less intense general motivation. Within the realm of normal personality traits, the sample was less tense and suspicious, and more conscientious, sensitive, and liberal than the norm group. Their work motivation was comparable to that of welfare clients in another project.
2. There were numerous and consistent subgroup differences on the inventory scales and interview variables that indicated, overall, that blacks and subjects with lower IQs and less education were less motivated, had lower self-concepts, and were more externally oriented.
3. The factor analysis of the psychometric battery produced 12 broad dimensions of client motivational structure, with most of the factors being instrument-specific. The factor analyses of the value and activity data from the structured interview produced parsimonious descriptions of these domains.
4. The correlational analyses which assessed the relationships between inventoried motivational characteristics and values and activities resulted in few relationships of substantial magnitude. The one exception to the pattern, which is consistent with the subgroup differences noted previously, is that race and IQ were significantly correlated with several motivational and value dimensions.

For additional information about this project, see Hinman S., & Bolton, B. Motivational dynamics of disadvantaged women. *Psychology of Woman Quarterly*, 1979, Fall issue.

APPLICABILITY: In conclusion, the results of this investigation contribute to the further understanding of

the motivational status of disadvantaged female clients, although it is impossible to infer a casual relationship between decreased motivational and disadvantage. Lack of motivation may explain nonachievement.

175 Development and Evaluation of a Program to Utilize Clients as Peer Helpers in a Comprehensive Rehabilitation Center

Principal Investigators: G. Tim Milligan, M.S.E.
Robert L. Akridge, Ed.D.

Status: Completed

Dates: March 1977-October 1978

Cost: Annual \$22,997 Projected Total \$41,000
RT Annual \$14,717 RT % of Annual Total 64%

Annual Report Reference: #14, Page 183, R-163

OBJECTIVES: To provide basic helping skills training to a selected group of peer leaders in a comprehensive rehabilitation center and evaluate the effectiveness of the training for rehabilitation clients in increasing their ability to serve as peer counselors.

METHODOLOGY: Members of the client/student body in a comprehensive rehabilitation center were polled to identify persons recognized as "peer helpers." The persons identified were trained in interpersonal skills, using RT-13's packaged program of instruction "Basic Helping Skills for Rehabilitation Workers." Pre-post measures of facilitation were taken.

The two persons functioning at the highest levels of facilitation were selected as trainers, and trained under supervision of another group of students. Pre-post measures of facilitation were taken with group II.

FINDINGS TO DATE: Pre-post data for Group I (clients trained by ARR&TC) and Group II (clients trained by peers) show the following results:

	Group I	Group II
Pre-training facilitation scores:	2.8	2.5
Post-training facilitation scores:	5.6	4.4

Group I, trained by ARR&TC trainers, was functioning slightly higher at intake and showed slightly more gain at the end of training than Group IV. However, given the small sample size and reliability of the rating instrument, the differences do not appear statistically significant. Both groups did show significant pre-post gain.

It is tentatively determined that rehabilitation clients of average intelligence and academic achievement can learn to interact with others in facilitative ways when trained with the Basic Helping Skills program by experienced trainers. Further, selected clients (i.e., those functioning high on facilitation) can serve as effective trainers, under supervision, for peers.

The materials in the Basic Helping Skills Training for Rehabilitation Workers were appropriate and usable without modification.

APPLICABILITY: Rehabilitation facilities recognize that the milieu of the facility environment can retard or accelerate client progress toward rehabilitation goals. The negative effects of institutionalization can offset the values of various facility programs (e.g., work adjustment, vocational training, etc.).

In rehabilitation centers, as in society, the major support system for many clients is the peer group, i.e., other clients in the facility.

With a goal of providing a facilitative environment, it follows that facilities need to influence peer groups to be helpful. There is little evidence to show that rehabilitation facilities have been able to systematically capitalize upon the peer-group support system to provide the most facilitative environment.

A way of influencing client peer groups to be a positive influence upon persons learning social-

ization skills is needed. One way is to train leaders among the client population in rehabilitation facilities as peer counselors.

Basic Helping Skills for Rehabilitation Workers (Interpersonal Skills Training) has potential for helping accomplish those goals.

176 Development and Evaluation of a Set of Systematic Training Units to Increase or Decrease Selected Client Behaviors (Behavior Skills Training)

Principal Investigator:	Robert L. Akridge, Ed.D.	
Status:	Completed	
Dates:	November 1976-October 1979	
Cost:	Annual \$24,530	Projected Total \$87,000
	RT Annual \$15,698	RT % of Annual Total 64%
Annual Report Reference:	#14, Page 224, R-164	

OBJECTIVES:

1. To identify a set of behaviors which handicapped individuals frequently need to increase or decrease in order to maintain themselves and grow in their situation.
2. To identify and/or develop training procedures and materials for increasing or decreasing the target behaviors.

METHODOLOGY:

1. Reviewed needs assessment research;
2. analyzed a national sample of taped counselor/client interviews;
3. reviewed treatment research;
4. surveyed counselor and client perception of perceived problems;
5. surveyed the field of personal growth training;
6. surveyed the popular self-help literature;
7. developed a method of conceptualizing and assessing basic life skills; and
8. conducted workshops with clients to increase or decrease certain target behaviors.

FINDINGS TO DATE: Basic life skills may be functionally conceptualized as the application of basic behavioral processes: sensing, conceptualizing, feeling, intending, and acting within particular spheres of functioning such as: physical, intrapersonal, interpersonal, ideological, financial, or technical. Skills may be organized around levels of actions ranging from the organism's autonomic self-maintenance responses to the person's most complex environmental coping.

Three 40-hour Life Skills Training workshops were designed to cover the range of skills at the different levels of actions as shown in Figure 1.

Levels of Actions

1. Physiological
2. Self-system
3. Interpersonal
4. Task Performance
5. Environmental Coping

Life Skills Training Workshop

Self-Control
Interpersonal Communications
Life Planning

APPLICABILITY: The RT-13 training staff is available to conduct demonstration workshops in these areas. Materials development proposals have been submitted to develop training packages for these client workshops which can be used by service providers throughout the rehabilitation system.

177 Psychosocial and Service Outcome Correlates of Acceptance of Disability

Principal Investigator: Richard Roessler, Ph.D.
Status: Completed
Dates: August 1977-February 1979
Cost: Annual \$7,666 Projected Total \$10,000
RT Annual \$4,906 RT % of Annual Total 64%
Annual Report Reference: #14, Page 236, R-165

OBJECTIVES: Research activity subsumes the following objectives:

1. To compare the value systems and life goals of two groups of clients, those who accept their disability (accepters) and those who do not (nonaccepters)
2. To determine whether a curvilinear relationship exists between hope and acceptance of disability and anxiety and acceptance of disability
3. To study the relationship of hope, anxiety, and acceptance of disability to completion of rehabilitation center program
4. To explore the counseling and personal adjustment training implications or empirical results of the project

METHODOLOGY: A voluntary sample (N=40) of physically disabled clients enrolled at the Hot Springs Rehabilitation Center was involved in the project. A night counselor contacted the students and requested their participation in the study.

Subjects completed a biographical form and several instruments, e.g., Cantril's (1965) Life Ladder, Rokeach's (1973) Value Survey, Taylor's Manifest Anxiety Scale, and Linkowski's (1971) Acceptance of Disability Scale. Other demographic and Center outcome data were secured from the clients and from Center records.

FINDINGS TO DATE: One phase of this study confirmed the hypothesis that moderate levels of client hope and anxiety are related to higher levels of acceptance of disability. In other words, acceptance of disability is negatively affected by too low or too high levels of either variable. Although more conceptualization and research is needed regarding strategies to raise anxiety, treatment techniques do exist to accomplish the other objectives. To decrease excessively high hope of clients, counselors must help them examine self-delusional constructs and develop realistic self-perceptions to supplant currently held unrealistic ones. Techniques for increasing hope include helping the individual change the self-depreciating cognitions associated with depression and develop expectations that personal goals can be achieved. Rehabilitation clients handicapped by excessive anxiety might profit from desensitization and relaxation training, intensive one-to-one personal counseling, or role playing and vicarious learning techniques.

Another study which was completed in this project, Goals of High and Low Accepters of Disability (Roessler & Boone, 1979), showed no significant relationship between level of acceptance of disability and type or number of life goals held. Given this similarity on type and number of goals, future acceptance of disability research might concentrate on contrasting high and low accepters on other variables such as (a) subjective possibilities that life goals can be attained, (b) locus of control, and (c) capabilities for reality surveillance and grounding.

The similarity between high and low accepters of disability was also found in terms of rankings of Rokeach's (1973) terminal and instrumental values. Bandura (1977) offered several possible explanations for the values and goal similarity of the two groups. He first pointed out that general intentions such as broad life goals or values "provide little basis for regulating one's efforts or for evaluating how one is doing" (p. 162). Bandura (1977) also pointed out that individuals may differ on the level of mastery that they attribute to themselves; i.e., on their belief that they could realize those goals and values in their lives. The mastery concept relates to the alternate hypothesis suggested by the goal study which emphasized subjective probabilities of success, locus of control, and capabilities to interpret reality accurately as possibly discriminating between high

and low accepters of disability. These implications for performance of rehabilitation clients have been utilized in the development of a new research proposal (R-177, Psychological and Environmental Correlates of Successful Completion of Vocational Training in a Comprehensive Rehabilitation Center).

APPLICABILITY: To date, implications of the study for counseling can be stated in several broad principles. First, it appears in this research that accepters and nonaccepters of disability may be more similar in personal life goals and values than might be expected from other research. Hence, it may be more profitable to look toward other variables such as expectancies (locus of control and interpersonal trust), subjective probabilities of success, and interpretations of disability when attempting to facilitate adjustment to disability. Although it is important to help clients clarify their goals and values, it may be even more important to help them develop goals they believe they can achieve without excessive personal cost and personal orientations which emphasize seeing oneself as capable of initiating action and others as trustworthy in the sense of tangibly following through on promised rewards. Roessler and Henderson (1978) pointed out several ways that counselors could increase client perceptions of personal effectiveness through task structuring, counselor reinforcement of internal control statements by the client, problem solving training, and staff expectations.

178 An Investigation of the Results of the Annual Review of Ineligibles and Non-rehabilitants

Principal Investigator:	Reed Greenwood, Ed.D.	
Status:	Completed	
Dates:	January 1977-May 1978	
Cost:	Annual \$7,666 RT Annual \$4,906	Projected Total \$23,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 378, R-67	

OBJECTIVES:

1. To develop a procedure for conducting an analysis of the outcomes of the annual review of ineligibles and non-rehabilitants.
2. To conduct a study of the outcomes of the annual review.
3. To analyze the results of the study.
4. To disseminate the results of the research to all interested rehabilitation administrators and policy makers.

METHODOLOGY: The methodology called for the use of a form on which all reviews would be reported by the three participating agencies. The review form required the following information:

1. Reason why the case was not considered for further action beyond a field office review.
2. Date of referral and current status if the case was back on the caseload at the time of review.
3. Information on the cases which were considered for further action beyond a field office review in terms of the type of action attempted (personal, telephone, mail, or other contact), an estimate of the time spent in making the contact, and the outcome of the action (entered caseload or did not enter caseload and reason for same).

The methodology required a total enumeration of the reviews in each state with counselors completing the one page form outlined above. The data were collected at the end of the Fiscal Year, 1977, and forwarded to the Arkansas Rehabilitation Research and Training Center, for processing and data analysis. In addition to the form on the annual review process, each agency submitted the standard RSA-300 client data form with each review (each RSA-300 was submitted with identifying information removed). This allowed the investigators to analyze the reviews in terms of client characteristics such as race, sex, etc.

FINDINGS TO DATE: Of the 2332 cases reviewed by the three agencies only 17 cases re-entered a caseload following counselor action as part of the annual review of ineligible and non-rehabilitants. In a sense, these 17 cases represent that portion of cases reviewed for which the annual review was successful. Although the sample size of 17 cases is much too small to make comparisons among the three agencies, several observations are possible. First, the action primarily responsible for the client re-entering the caseload was most often personal contact by the counselor. Mail contacts resulted in few re-entries. Although personal contact by the counselor appears to be the more effective technique for reviewing ineligible and non-rehabilitants to guarantee their access to vocational rehabilitation benefits, there remain two questions yet to be answered. First, how many of the 17 cases re-entering the caseload following the annual review would have re-entered without the review? Second, is the annual review an efficient mechanism for insuring benefits to clients closed due to lack of vocational potential? The first question cannot be answered by the data collected in this study. However, two aspects of the efficiency of the review may be addressed from the data collected in this study—cost in terms of counselor time and the probability of potential client benefit.

If the resources required to conduct the field office reviews are ignored, it required a total of approximately 166 working days to result in 17 cases reentering the caseload (assuming that all 17 came back as a result of counselor intervention). Of those 17 cases, most are expected to be closed ineligible or non-rehabilitated. Further, the probability that a counselor-action review results in potential client benefit in terms of re-entry into the caseload is estimated to be less than two chances in 100 (.017). The small probability of success (re-entry) and the high cost of the annual review procedures suggest that the annual review of ineligible and non-rehabilitants may not be an efficient technique for insuring vocational rehabilitation benefits to those closed due to a lack of potential for achieving a vocational goal.

The following publications have been completed:

1. Cooper, P.G., Greenwood, R., & Davis, S. An investigation of the results of the annual review of ineligible and non-rehabilitants.
2. Cooper, P.G., Greenwood, R. & Davis, S. The annual review of ineligible and non-rehabilitants: A report on its impact. **Research Report.** Arkansas Rehabilitation Research and Training Center, Fayetteville, Arkansas. February 1978.

APPLICABILITY: It is anticipated that policy makers at both the state and federal levels will find the results of this research significant in examining the continued requirement for the annual review of ineligible and non-rehabilitants. It would appear that alternative means for assuring equal access to the vocational rehabilitation system would warrant serious consideration.

179 Rehabilitation Clients' Psychological Adjustment: A Six-Year Longitudinal Investigation

Principal Investigator:	Brian Bolton, Ph.D.	
Status:	Completed	
Dates:	October 1977-September 1978	
Cost:	Annual \$26,830 RT Annual \$17,170	Projected Total \$29,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 388, R-168	

OBJECTIVES: The primary purpose of this investigation was to assess the long-term psychological adjustment of a sample of clients from the time of acceptance for rehabilitation services to follow-up more than six years later. Secondary objectives included the assessment of relationships among these three major classes of variables—vocational, psychological, and social adjustment. Clearly, the long-term adjustment is the issue of central concern in this project.

METHODOLOGY: In conjunction with the nationwide "Counselor-Client Interaction Project," 90 rehabilitation clients in Arkansas completed a battery of psychological inventories at the time of acceptance for services, which was sometime between November 1967 and April 1972. Each

client received appropriate rehabilitation services through one of eight district offices or two facility programs, one for developmentally disabled persons and the other for alcoholic clients.

In November, 1977, the counselors who had originally worked with the 90 clients, or their successors, attempted to locate the ex-clients, and deliver a package of follow-up questionnaires. Each of the former clients who completed and returned questionnaires received a \$15 payment.

The research sample for the study consisted of 32 former clients of the ARS. While the overall response rate (usable data) may seem low (36%), when corrected for those individuals who were known to be deceased, in prison, or could not be located, the effective response rate becomes 54%.

Three aspects of rehabilitation clients' long-term adjustment were measured in this investigation. The three categories of variables are:

1. vocational adjustment, i.e., work status, earnings, etc.
2. psychological adjustment, i.e., self-esteem, anxiety, depression, etc., and
3. social adjustment, i.e., family relationships, participation in various activities, etc.

Measures of vocational and psychological adjustment were collected at acceptance for services and again at follow-up, while the assessment of social adjustment was made at follow-up only.

FINDINGS TO DATE

1. Rehabilitation Services did have a significant and substantial overall effect on the vocational adjustment of the research sample: the proportion of clients who were employed increased from 22% to 62%, while those in "not working" and "other" categories decreased.
2. However, not all clients benefited from vocational rehabilitation services: eight former clients (25%) in the research sample were not working and were also inactive at follow-up and five of the group were receiving some form of public assistance. The other three change patterns were: improvement in work status ($n=14$), retention of employment ($n=6$), and not working but active ($n=4$).
3. The beneficial effects of rehabilitation services on the psychological adjustment of the research sample were evident in significant overall improvement on two scales: Psychosis (Psy) and Number of Deviant Signs (NDS). Since both of these scales are empirically derived, and thus more resistant to social desirability responding, these positive changes are especially impressive. Although there was a significant decrease on Super-ego Strength (SES), the mean score at follow-up was still higher than the norm group mean.
4. Analyses of the individual clients' changes on the 20 psychological scales indicated that rehabilitation services did have a substantial influence on long-term psychological adjustment, but not in a consistent manner. Some clients made significant improvements in various aspects of personality functioning, while others deteriorated significantly. Five times as many clients made significant changes as would be expected due to unreliability of the measurements.
5. Two of the 20 psychological variables were exceptionally stable over the 6-year interval, Alertness (.75) and Extraversion (.67), and four others were moderately stable, Independence (.58), Psychosis (.58), Hysteria (.52), and Super-ego Strength (.49). In contrast, the self-concept variables were the least stable, indicating that self-esteem may be more amenable to modification as a result of rehabilitation services.
6. On three global self ratings completed at follow-up, clients typically viewed their physical health as less satisfactory overall than their emotional adjustment, while most characterized their family relationships as good. This sample of former clients reported a wide range of participation in social activities, from none to a total of 16. The correlation of .67 between emotional adjustment and social participation indicates that socially active former clients perceived themselves as better adjusted.
7. Consistent relationships among work status, Physical Self (Phy), Number of Deviant Signs (NDS), Hypochondriasis (Hs), social participation, and rated physical health suggest the existence of a core dimension of vocational-psychosocial adjustment underlying rehabilitation success. However, the modest magnitude of the relationships between improved vocational adjustment and

improved psychosocial adjustment indicates that although these two types of criteria may be mutually facilitative, they represent distinct aspects of client outcome.

For additional information about this project, see Bolton, B., Rehabilitation clients' psychological adjustment: A six-year longitudinal investigation. *Journal of Applied Rehabilitation Counseling*, 1979, 9(4), 133-141.

APPLICABILITY: In summary, the results of this investigation suggest that the provision of rehabilitation services does have a significant impact on the long-term vocational and psychosocial adjustment of clients. However, not all clients benefit in all areas of functioning. But the vast majority do evidence improvement in some types of psychological or vocational adjustment.

180 Evaluation of the RIDAC (Rehabilitation Initial Diagnosis and Assessment for Clients) Project for the Arkansas Rehabilitation Services

Principal Investigator:	Brian Bolton, Ph.D.	
Status:	Completed	
Dates:	July 1975-October 1978	
Cost:	Annual \$ 14,450 RT Annual \$7,359	Projected Total \$56,000 RT % of Annual Total 51%
Annual Report Reference:	#14, Page 401, R-169	

OBJECTIVES: The essence of the RIDAC (Rehabilitation Initial Diagnosis and Assessment of Clients) concept is an initial concentrated, mini-evaluation of rehabilitation potential and vocational capacity for new clients, as well as "difficult" cases that are not progressing satisfactorily. The specific objectives of the Arkansas RIDAC unit, which was established in the Little Rock district office, were as follows:

1. To reduce the time lag between referral of clients for services and their movement into active status.
2. To reduce the number of applicants who are closed in 08 status, i.e., closed from referral.
3. To increase the relevance of client diagnostic information for counselors' uses in planning with their clients, or in justifying closures in 08 status.
4. To increase the number of severely disabled clients accepted for services.
5. To increase client participation in, and satisfaction with, the rehabilitation process.

METHODOLOGY: The rehabilitation counselors in the Little Rock area referred clients to the RIDAC unit for evaluation using as selection criteria the main objectives of the project. It is important to emphasize that each counselor decided which clients would be assigned to RIDAC; there was no attempt to interfere with the counselors' decision-making function. Hence, the research evaluation of the project was as much concerned with how counselors use RIDAC evaluation services, as with the effectiveness of the RIDAC unit.

During the 3-year evaluation period a total of 2,108 rehabilitation clients received some type of RIDAC services. Of this group, 63 clients were referred by 31 counselors. The remaining 2,045 clients were sponsored by 22 counselors who can be organized into five categories: (a) Little Rock Office general caseloads (10 counselors; 1,357 clients), (b) Little Rock Office SSDI-SSI caseloads (3 counselors; 271 clients), (c) Work-Study program caseloads (4 counselors; 168 clients), (d) WIN-VR caseload (1 counselor; 126 clients), and (e) Specialized caseloads such as alcoholics, SCI, etc. (4 counselors; 123 clients).

Variables measuring client characteristics, service provision, and client outcomes were selected from the R-300 records for the purposes of describing patterns of counselors' uses of the RIDAC unit and evaluating the impact of the RIDAC services on caseload management and client outcomes, as specified in the major objectives of the project. The research design entailed comparisons between the clients referred to the RIDAC unit for evaluations and those clients who received traditional (purchased) evaluation services. In addition to the statistical analyses of case-

load data, two other types of evaluation were collected: counselors' opinions on the value of RIDAC and clients' reactions to the RIDAC unit.

FINDINGS TO DATE: The data analyses were restricted to comparisons between 1,357 RIDAC clients and 2,863 traditional clients of the 10 Little Rock office general counselors. There were three reasons for restricting the presentation to these two samples: (a) They are by far the largest groups and thus provide the most reliable summary statistics, (b) They represent standard caseloads in the state agencies and hence provide a basis for the most broadly generalizable conclusions, and (c) While the remaining groups are comprised of various types of specialized caseloads, the data analyses are consistent with the results for the general caseload samples.

The 1,357 clients who were referred to the RIDAC unit by the 10 general counselors comprise about one-third (32.2%) of the total number of clients served during the 3-year evaluation period. In other words, the 10 counselors selected one client in every three from their caseloads for referral to the RIDAC unit. However, there was considerable variability among the 10 counselors: at the extremes one counselor referred fewer than one client in ten (8.5%) to the RIDAC unit while another counselor referred more than one-half (56.5%) of his caseload.

Overview of Client Outcomes: In contrast to the 30.0% of the traditional clients who were closed in 08 status from referral (00) without cost, none of the RIDAC clients were closed in this category. These data suggest that the second objective of the RIDAC project was achieved, i.e., a smaller proportion of the RIDAC clients were closed 08. The difference between the RIDAC and traditional samples in 08 closures from applicant (02) or extended evaluation (06) was not significant (16.9% versus 19.8%). Furthermore, of the clients who were accepted for services, a smaller proportion of the RIDAC sample were closed successfully (29.5% versus 38.7%), and the RIDAC clients were generally in active status slightly longer, as reflected by the higher proportion (but not significant) still receiving services (58.6% versus 53.8%). However, the RIDAC clients were typically more difficult cases.

Client Characteristics of Referral: The client data provided clear evidence that the fourth objective of the RIDAC project was achieved, i.e., the proportion of severely disabled clients accepted for services was much higher (57.0% versus 37.4%). Also, a higher proportion of severely disabled clients were referred to the RIDAC unit (52.5% versus 28.6%) and a higher proportion of severely disabled clients who received RIDAC evaluations were successfully closed (47.1% versus 32.3%).

Other consistent differences between the RIDAC and traditional samples were: a greater proportion of the RIDAC clients were multiply handicapped, possessed intellectual and psychiatric disabilities, were younger, and receiving public assistance at referral, and a smaller proportion were competitively employed at referral. In general these differences between the referred, accepted and successfully closed samples suggest that the more difficult clients, i.e., those with lower probabilities of successful outcome, received RIDAC evaluations.

Clients Closed in Status 08: Comparisons between the RIDAC and traditional clients who were closed 08 from 02 or 06 revealed several differences. While the RIDAC clients were processed a little faster than the traditional clients, their average case cost was more than twice as high because they received more extensive evaluations. It seems reasonable to speculate that the counselors felt that the RIDAC clients required more thorough documentation to justify the 08 closures, although neither the reasons for 08 closure nor the characteristics of the samples give any indication regarding the particular nature of the RIDAC clients. However, it is noteworthy that fewer than one in ten (9.6%) of the RIDAC clients were closed 08 because their disabilities were too severe, especially considering that more than one-half (52.5%) of the clients referred to the RIDAC unit were severely disabled.

Clients Closed in Status 26: Although the time-in-status data indicated that the RIDAC clients who were successfully closed moved a little slower than the traditional clients, the differences were not large and can reasonably be attributed to the greater average difficulty of the RIDAC clients. Furthermore, the average case costs were very similar. The differences in the services rendered to the RIDAC clients and the traditional clients are consistent with the previously observed differences in the types of disabilities, i.e., the greater proportion of intellectually and psychiatrically disabled clients in the RIDAC sample required more psychosocial and vocational adjustment services while the higher rate of restoration services provided for the traditional clients reflects the greater proportion of physical impairments in that sample. Finally, slightly more of the

RIDAC clients were competitively employed, but more of them were still receiving public assistance at closure.

Clients Closed in Statuses 28/30: For the unsuccessfully closed clients in the RIDAC and traditional samples the average number of months from referral to closure was very similar. The large difference in case costs (\$651 versus \$1,305) is due to a relatively small proportion of clients in the traditional sample who received extensive restoration services. Additional insight into the unsuccessful RIDAC clients is given by the excessive proportion who were closed for "lack of cooperation" (84.7% versus 58.3%). This difference is, of course, consistent with the greater average case difficulty of the RIDAC sample.

The first objective of the RIDAC project was to reduce the time lag between referral of clients for services and movement into active status. The average time in referral/applicant status for those RIDAC clients who were accepted for services and subsequently closed indicates that the RIDAC unit resulted in no improvement over the traditional evaluation procedures. In fact, the RIDAC clients were in 00/02 status slightly longer than the traditional clients. However, it would have been difficult to improve on the rapidity of the traditional evaluation process. Yet, the RIDAC unit did appear to accelerate the eligibility-decision process for those clients who were closed in status 08.

Counselor Evaluation of RIDAC: The third objective of the RIDAC project was to increase the relevance of client diagnostic information for counselors' uses in case planning and decision-making. The statistical data presented above suggest that the RIDAC unit was a useful resource to the 10 general caseload counselors. During the final month of the project the counselors wrote brief evaluative critiques of the RIDAC unit which were consistent with the results of the statistical analyses.

Client Evaluations of RIDAC: The final objective of the RIDAC project was to increase client satisfaction with the rehabilitation process. In the fall of 1977, 200 former clients who had received evaluation services from the RIDAC unit were mailed a brief questionnaire to ascertain their opinions and reactions, in order to collect data pertaining to their satisfaction with the RIDAC unit. Eighty-six questionnaires were returned, a 43% response rate. As with the counselors, clients' evaluations of the RIDAC services were very favorable.

For additional information about this project, see Bolton, B., & Davis, S. Rehabilitation counselors' uses of an experimental RIDAC unit. *Journal of Rehabilitation*, 1979, Fall issue.

APPLICABILITY: In summary, the available evidence indicates that the objectives of the RIDAC unit were generally achieved. It can be concluded that the RIDAC concept has great potential for improving rehabilitation service delivery to handicapped clients in VR office settings.

181 Research on the Psychosocial and Vocational Adjustment of Spinal Cord Injured Clients

Principal Investigator:	Daniel Cook, Ph.D.	
Status:	Continuing	
Dates:	March 1974-December 1978	
Cost:	Annual \$15,331 RT Annual \$9,811	Projected Total \$89,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 196, R-125	

OBJECTIVES:

1. To design a comprehensive research and evaluation strategy to assess the effectiveness of a model Regional System of Spinal Injury Rehabilitation.
2. To implement Personal Achievement Skills Training with a group of SCI at the Hot Springs Rehabilitation Center.
3. To complete a comprehensive review of the research literature dealing with psychosocial and vocational attributes of the SCI.

University of Arkansas

4. To implement a comprehensive research and evaluation strategy assessing the effectiveness of a Model Regional System of Spinal Cord Injury Rehabilitation.
5. To describe the sample of SCI persons making use of project services.
6. To assess the extent to which SCI clients' personal, social, and vocational needs are met by the rehabilitation program at the Hot Springs Rehabilitation Center.
7. To compare those SCI clients who successfully complete their vocational training programs with those clients who did not for the purpose of isolating client characteristics which are predictive of success.
8. To devise specific intervention strategies to meet the research defined needs of the SCI.
9. To complete a comprehensive review of psychosocial and vocational research pertaining to the SCI.
10. To measure the non-economic and quasi-economic contributions of the SCI to society.
11. To assess SCI clients' degree of satisfaction with rehabilitation services.

METHODOLOGY: The research design for measuring and monitoring client variables considers assessing the client's economic, environmental, social, and psychological status from entry into the project, through treatment, to project completion.

FINDINGS TO DATE: The following implications appear from the currently completed data analyses.

1. Injured at or before 18, many clients have been in a dependent status for a significant period of time and have developed few vocational commitments and behaviors.
2. Most SCI clients viewed rehabilitation as access to medical and surgical services.
3. Diversity of goals selected by SCI clients underscores the need for individualized planning with clients; independence goals are somewhat more important to clients than vocational or social goals.
4. Like other disabled client groups, project clients reported low satisfaction levels of work, psychological, and health related needs.
5. Direct counseling with clients regarding their goals and objectives for the future is also required.
6. Psychological adjustment to spinal cord injury is highly idiosyncratic.
7. Project procedures for identifying and involving spinal cord injured individuals in rehabilitation services appeared effective.

APPLICABILITY: Results of this project should improve services to SCI clients at the HSRC and other comprehensive rehabilitation facilities.

182 Development and Evaluation of an Interpersonal Skills Training Package

Principal Investigator:	Robert L. Akridge, Ed.D.	
Status:	Continuing	
Dates:	February 1975-October 1980	
Cost:	Annual \$16,078 RT Annual \$11,302	Projected Total \$97,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 21, R-136	

OBJECTIVES:

Phase I

1. To determine inter-rater reliability of the following measures: (a) Counselor Facilitation Scale, (b) Client Self-Directive Behavior Scale, (c) Client Self-Revealing Scale, and (d) Client Internalization/Externalization Scale.

2. To study the relationship between ratings on these measures and client outcome in terms of status at closure.
3. To compare the relationship of the above measures with a comprehensive battery of psychological tests.

Phase II

1. To assess the impact of the IPS training package on client outcome, when used by VR counselors who have been trained by VR agency trainers.
2. To assess impact of the IPS package on the interpersonal environment of a comprehensive VR center.

METHODOLOGY:

Phase I

1. Tape recorded counselor/client sessions will be rated (tapes already available in data bank.).
2. Client closure status, R-300 data and client psychological test sub-scores are also available from the data bank.
3. Correlational analysis and multiple regression analysis will be used to analyze the data.

Phase II

1. Selected state agencies and rehabilitation centers will be asked to participate in the development of a comprehensive field test of the training program.
2. Clients of experimental group counselors (who will receive IPS training) and control group counselors (no IPS training) will be tracked with systematic assessment for a period of at least 2 years.
3. Specific data gathering procedures, instruments, and methods of analysis will be developed through consultation with participating rehabilitation agency personnel.

FINDINGS TO DATE:

1. Editorial and instructional design work on the IPS materials have been completed.
2. Developmental field tests have been conducted.
3. Phase I data collection and analysis have been completed.
4. A "second generation" trainer (trained by an RT-13 trainer) conducted an IPS experiment with nursing students. The experimental group nurses showed significantly higher skill levels on all criteria measures.
5. Plans are being completed to work through regional continuing education programs to conduct an evaluation of the IPS package in terms of whether counselors, trained by second generation trainers, influence client behavior to a comparable degree.
6. The IPS training package including form training manuals and one audio tape was completed.
7. A comprehensive field test of the package was conducted in a state agency where 150 counselors received 18 hours of basic training and 50 of those received 18 hours of additional training. Assessments relating to attitude, knowledge and skill acquisition were made. This data is presently being analyzed.

APPLICABILITY: The IPS training program purports to effect an improvement in basic counselor helping skills. With such training, counselors should be expected to achieve superior results in helping clients define and achieve goals and resolve problems.

183 Systematic Caseload Management in Rehabilitation Counseling

Principal Investigators: Reed Greenwood, Ed.D.
Stanford E. Rubin, Ed.D.

Status: Continuing

Dates: March 1976-February 1980

Cost: Annual \$15,331 Projected Total \$60,000
RT Annual \$9,811 RT % of Annual Total 64%

Annual Report Reference: #14, Page 34, R-151

OBJECTIVES: The overall objective of this project is to develop the Systematic Caseload Management (SCM) training package. The training contained in that package is directed at upgrading rehabilitation counselor skills related to the management of an entire caseload of rehabilitation clients.

SCM training covers three major phases: Planning, Time Management and Progress Review. **Planning** focuses on the specification of goals and action plans to be accomplished by the counselor. The counselor plans for the use of his/her time, resources and all counselor tasks. **Time Management** deals with the effective allocation of rehabilitation counselor time for the critical tasks performed by the counselor to meet client, counselor and agency needs. **Progress Review** is the regular assessment by the counselor of his/her accomplishments to determine if the planned goals have been achieved. These three phases are directed to the following three basic questions: (1) What is to be accomplished and how? (2) When is the task done? and (3) Was the task done and if not what should be done to accomplish it?

During SCM Training the counselor will be introduced to the knowledge and skills necessary to plan, manage time and assess progress. There are also trainee participation exercises designed to promote the learning of the principles through direct experience. Additionally, the trainee will be provided with working tools for implementing the principles of effective planning, time management and progress review.

METHODOLOGY:

1. Three training modules will be developed. The first training module will be directed at teaching effective planning skills. The second training module will be directed at teaching effective time management skills. The third training package will be directed at teaching effective program review skills.
2. Assessment devices will be developed to assess the following areas of training:
 - a. Cognitive Gain: Tests will be developed to measure trainee comprehension of the concepts and principles presented in the training modules.
 - b. Skills Gain: The degree to which the trainees learn the skills advocated in the training modules will be determined via direct observation of their capability to emit the desired behaviors. Necessary rating scales will be developed.
 - c. Attitudinal Evaluation: An evaluation form will be developed to measure the trainee's satisfaction with the training.
3. Assessment of the Training Modules.
In order to determine the effect of training, the following will be performed:
 - a. A random sample of rehabilitation counselors will be drawn and divided into an experimental (training) and a control (no training) group.
 - b. Knowledge of appropriate behavior and ability to emit such behavior will be assessed prior to training.
 - c. The experimental group will receive the Facilitative Management Training.
 - d. The control group will receive no training.

- e. Following completion of training the counselor trainees will be assessed to determine if any cognitive or behavioral development has occurred. Also, the attitudinal evaluation described above will be administered to the experimental group.

FINDINGS TO DATE: A rough draft of the training package has been developed. It was tried out with a group of in-service training directors from state rehabilitation agencies in Region VI in February, 1979 in order to obtain feedback on the package. In general, the group liked the SCM training packages but suggested some revising. The revisions are currently being completed in preparation for another try out of the package with a group of state rehabilitation agency rehabilitation counselors from Region VI in January, 1980.

APPLICABILITY: The results of this research could have considerable impact on the practice of rehabilitation counseling, particularly in terms of reducing caseload size, increasing case processing effectiveness, and improving non-client interaction. For the first time, a comprehensive model should be available within which the counselor can be maximally effective in the role and functions prescribed by the system and by client needs.

184 Information Exchange Effectiveness in Rehabilitation Counseling

Principal Investigator:	Stanford E. Rubin, Ed.D.	
Status:	Continuing	
Dates:	March 1976-February 1980	
Cost:	Annual \$42,161 RT Annual \$26,981	Projected Total \$126,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 43, R-158	

OBJECTIVES: The overall objective of this project is to develop the Information Exchange Package. The training contained in that package is directed at teaching rehabilitation counselors:

1. the types of information that should be collected during the intake interview.
2. the types of information that should be disseminated to a client during the intake interview.
3. an effective intake interview information collection style, and
4. an effective intake interview information dissemination style.

METHODOLOGY:

1. Two training modules will be developed. The first training module will be directed at teaching effective information collection skills. The second training module will be directed at teaching effective information dissemination skills.
2. Assessment devices will be developed to assess the following areas of training:
 - a. Cognitive Gain: Tests will be developed to measure trainee comprehension of the concepts and principles presented in the training modules.
 - b. Skills Gain: The degree to which the trainees learn the skills advocated in the training modules will be determined via direct observation of their capability to emit the desired behaviors. Necessary rating scales will be developed.
 - c. Attitudinal Evaluation: An evaluation form will be developed to measure the trainee's satisfaction with the provided training.
3. Assessment of training modules. In order to determine the effect of training, the following will be performed:
 - a. A random sample of rehabilitation counselors will be drawn and divided into an experimental (training) and control (no-training) group.
 - b. Knowledge of appropriate information dissemination and information collection behavior and ability to emit such behavior will be assessed prior to training.
 - c. The experimental group will receive the Information Exchange Training.

- d. The control group will receive no training.
- e. Following completion of training the counselor trainees will be assessed to determine if any cognitive or behavioral development has occurred.

FINDINGS TO DATE: A rough draft of the training package has been developed. It was tried out with a group of in-service training directors from Region VI in October, 1978, in order to obtain feedback on the package. In general, the group liked the training package but suggested some revision. That revision was completed and the revised training package was tried out again in July, 1979 with a group of state rehabilitation agency rehabilitation counselors from Region VI. The rehabilitation counselors also liked the training package but suggested some additional revision. Those revisions are currently being completed in preparation for another try out of the package with another group of state rehabilitation agency rehabilitation counselors from Region VI in February, 1980.

APPLICABILITY: Increasing rehabilitation counselor skills in information collection and information dissemination should make them better providers of services to the severely disabled. This training program which is designed to increase such counselor skill should therefore eventually impact on client satisfaction with agency services.

185 Facilitative Interaction Techniques in Rehabilitation Counseling

Principal Investigator:	Roy C. Farley, Ed.D.	
Status:	Continuing	
Dates:	March 1976-February 1980	
Cost:	Annual \$34,496 RT Annual \$22,076	Projected Total \$98,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 55, R-159	

OBJECTIVES:

1. To continue the refinement of the Facilitative Case Management model of rehabilitation counseling through research.
2. To develop a training package for rehabilitation counselors that will facilitate the counselor's interaction skills by teaching them to:
 - a. identify moment-to-moment responses that are used to exchange information with the rehabilitation client.
 - b. identify response modes.
 - c. analyze interaction profiles.
 - d. identify facilitative and nonfacilitative uses of responses.
 - e. examine alternative modes of responding.
 - f. identify preferred modes of responding.
 - g. evaluate their own interaction style.
3. To evaluate the effectiveness of the training package.

METHODOLOGY:

1. Development of the training package.

The training package will include the following:

- a. a pre-workshop training manual which will include the theoretical foundation of the training program.
- b. an instructor's manual which will include an outline and/or narrative of the materials to be covered during the training.

- c. a participant's workbook which will contain all of the forms and training aids that would typically be distributed to the participants during the workshop.
- d. audio tapes which contain recordings of counselor/client interaction to be used as part of training exercises.
- e. a typescript which can be used as visual reference to aid in understanding the audio-taped dialogues used as part of the training activities.
- f. other training aids that might be useful in the presentation of the material (e.g., overhead transparencies, etc.).

The training program will be developed to include the following three components:

- a. a didactic component which will be presented via lecture and modeling utilizing items (b), (c), and (f) above. The didactic component will include the following general outline:
 - i. definition of terms.
 - ii. rationale.
 - iii. objectives.
 - iv. principles for the effective use of each skill.
- b. A discrimination component designed to train counselors to discriminate between effective and noneffective techniques. This will be done via modeling, role-playing activities, and utilizing items c., d., and e. above.
- c. An experiential component designed so that participants will be provided the opportunity to practice and experience the use of various techniques. This will be done via role-playing activities.

2. Evaluation of the training package.

In order to determine the effect of training, participants' behavior will be assessed in the following three areas:

- a. Cognitive gain: tests will be developed to measure participant's comprehension of the concepts and principles presented during the training and in the pre-workshop manual.
- b. Attitude: an evaluation form will be developed to measure the participant's attitude toward the training. This evaluation will involve an assessment of the participants:
 - i. belief of the concepts and principles presented.
 - ii. affective reaction toward the training.
 - iii. predisposition to act on the principles taught.
- c. Action (on-the-job performance): the degree to which the participants can actually perform the desired actions taught during the program will be determined via direct observation of their capability to emit the actions. Necessary rating scales/forms will be developed.

The following general research methodology will be performed:

- a. A random sample of rehabilitation counselors will be drawn and divided into an experimental and control group.
- b. Knowledge of appropriate behavior and ability to emit such behavior will be assessed prior to training.
- c. The experimental group will receive training.
- d. The control group will receive no training.
- e. Following completion of training, the counselor trainees will be assessed to determine if any cognitive or performance change has occurred. Also, the attitudinal evaluation described above will be administered to the experimental group.

FINDINGS TO DATE:

1. The need for training in this area has been confirmed through the evaluation of the basic Facilitative Case Management Training Package, Project R-161. The results of this project indicate a need for a refinement in the training modules that relate to counselor interaction style in the basic package.
2. Drafts of the trainer's manual and participant's manual have been completed.
3. A process of user review has been initiated utilizing the following steps:
 - a. copies of draft material submitted to a group of users which include:
 - i in-service training directors
 - ii rehabilitation program people
 - iii rehabilitation counselors
 - iv client consumers
 - b. users participate in a training session to experience training in its present developmental form.
 - c. evaluation forms completed to systematize user feedback on draft materials and training session.
 - d. feedback from users will be incorporated, as appropriate into revision and refinement of material.
4. Tentative assessment devices for the evaluation phase of the project have been developed and tried in a pilot study. They include:
 - a. a cognitive development test
 - b. an attitudinal evaluation scale
 - c. a rating guide for rating taped counselor/client instruction.

Revision and refinement of these instruments have begun.

APPLICABILITY: This project should result in findings which could be used by rehabilitation agency staff development supervisors, rehabilitation counselor supervisors, and rehabilitation counselor educators.

The results of the research should have greatest relevance to the practice of rehabilitation counseling. If the proposed training program results in increased counselor effectiveness, ongoing training programs could be adopted in various rehabilitation settings.

186 Goal Planning in Rehabilitation Counseling

Principal Investigator:	Richard Roessler, Ph.D.	
Status:	Continuing	
Dates:	March 1976-February 1980	
Cost:	Annual \$26,830 RT Annual \$17,170	Projected Total \$90,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 65, R-160	

OBJECTIVES:

1. To develop a goal-setting module that enhances counselor diagnosis and planning skills and client participation in the development of the individualized written rehabilitation program.
2. To develop and pilot test a counselor training program in goal-setting.
3. To gather empirical data regarding the effects of the goal-setting module on client outcome and counselor and agency performance.

METHODOLOGY: The effect of the goal-setting module on counselor diagnostic skills will be assessed through the quality of counselor vocational analysis determinations and rehabilitation plan development for a test case. In the exercise, counselors will be provided with complete evaluation data on a client from the DOT and to justify such choices on the basis of the client's Physical, Intellectual, and Psychosocial strengths and weaknesses evident in the client evaluation data. Counselors will also delineate a logical service program and timetable for achieving vocational goals and justify the selected services.

After counselors have completed the test exercises, agency supervisors who are familiar with the goal-setting skills in three areas: appropriate vocational choice determination, rehabilitation program design, and goal writing. In all, 25 counselor protocols will be rated by the two raters. The basis for ratings will be several anchored scales providing example counselor above average, average, and below average responses to the different tasks in the test case. The example materials and scales for rating counselor skill levels will be independently developed with Arkansas DVR counselors and supervisors and with personnel from RT-13 who are familiar with goal setting training.

Trained (experimental) and untrained (control) counselor group performance will be compared following the completion of training. The relationship between counselor test exercise performance scores and client satisfaction scores will be determined. A high positive relationship is expected between counselor exercise scores and the level of satisfaction with services reported by their clients.

Finally, a series of cognitive and behavioral skill measures will be developed to assess counselor incorporation of the goal-setting skills. These measures will be used in an experimental test of the program's impact on counselor behavior in a field setting.

FINDINGS TO DATE:

Goal Setting Model: Training materials can be divided into five main categories: acquiring necessary knowledge during the intake interview, using the medical evaluation effectively, planning psychological and work evaluation for the severely disabled, determining the vocational significance of client evaluation data, and conducting an effective IWRP interview. Each subsection contains didactic, discrimination and experimental segments.

Progress to date: In the past year, the material for the entire training package—Trainer's Guide, Participant's Workbook, Case Study Files—has been completed and pilot-tested with two different groups, members of the RT-13 advisory committee and a group of practicing rehabilitation counselors. As a result of each presentation, the various phases of the program have been edited and altered as appropriate.

To demonstrate the principles presented in the training, a series of exercises has also been developed for each phase. These exercises involve trainees in reviewing case data and completing certain activities for fictitious cases representing five different types or combinations of severe disabilities. One nonseverely disabled client, Frank Bonner, has been included for illustrative purposes also. The severely disabled clients are: **Ted Johnson** - a 32 year old male with diabetes and related lower extremity circulatory problems; **Jed Pierce** - a 27 year old male with a history of hypoglycemia, epilepsy, schizophrenia, and alcohol and drug abuse; **Larry Payton** - a 16 year old male diagnosed as mentally retarded with a speech impediment; **Melinda Bracken** - a 28 year old woman with rheumatoid arthritis and diabetes; and **Shirley Slead** - a 38 year old woman with respiratory problems, varicose veins, anxiety and depression.

For each client, a comprehensive set of case materials from the intake interview to the IWRP has been developed. These case materials provide models for the practices advocated in the various phases of the training.

Another development over the past year was the revamping of the section on the IWRP. Based on study of the IWRP's of 36 states and San Diego Case Review materials, a model form of the IWRP was developed. This form incorporates the information required by law for the IWRP as well as the data which should result from application of the goal-setting training principles.

The next phase of the program requires the development and testing of cognitive and behavioral skill assessment instruments. These measures should provide evidence of the extent to which counselors have assimilated the techniques of the goal-setting module. Following the instru-

mentation phase, an intensive experimental test of the goal-setting package is planned.

Information included in the goal setting model will be provided as a regular feature of RT-13 counselor training. Also, research discussing the effectiveness of the goal-setting technique will be disseminated through professional journals and associations. An introduction to the information processing and goal-setting phases of the module was given at the National Rehabilitation Association's Annual Meeting in Washington, D.C. (September, 1977) and a journal article outlining procedures for processing and summarizing client data was published by **Rehabilitation Literature** (Rubin & Roessler, 1978).

A recent presentation on the goal-setting training package at the American Personnel and Guidance Association, entitled Diagnostic and Planning Guidelines for Vocational Rehabilitation Counseling (Las Vegas, 1979), resulted in an invitation to present the training package at the World Seminar on Employment Counseling in Ottawa, Canada in the Fall of 1980. Roessler and Rubin (1979) have also completed an article for publication in the **Journal of Rehabilitation** which draws on several of the key principles discussed in the information and goal-setting phases of the project.

APPLICABILITY: Materials developed in the project will enable counselors to meet more effectively the mandates of the Rehabilitation Act of 1973. Rather than a policy change, the goal-setting techniques will provide a way to translate current policy into systematic skills that can be integrated into the training of prospective rehabilitation counselors and the practice of current rehabilitation counselors.

187 An Analysis of the Effectiveness and Efficiency of a Comprehensive Rehabilitation Center's Vocational Evaluation Unit

Principal investigator:	Daniel Cook, Ph.D.	
Status:	Continuing	
Dates:	June 1976-June 1979	
Cost:	Annual \$22,997 RT Annual \$14,717	Projected Total \$47,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 317, R-166	

OBJECTIVES: To determine the effectiveness and efficiency of pretraining work evaluation unit recommendations made at a large comprehensive rehabilitation center by:

1. analyzing client center outcome according to type of evaluation unit recommendations made,
2. analyzing client closure status by type of evaluation unit recommendation made, and
3. analyzing client post-service salary level by type of evaluation unit recommendation made.

METHODOLOGY: Two samples of Center clients were formed, a random sample of 100 clients exposed to work evaluation during 1974, and a sample of 305 clients who completed special instrumentation and were enrolled at the center 1977-1978. A specialized form which included select demographic and psychological information as well as evaluation unit recommendation made, actual center training assignment, and Center disposition was completed for each client. Data were analyzed via various descriptive and nonparametric techniques.

FINDINGS TO DATE: Replicated findings from both samples indicated no significant relationship between type of evaluation unit recommendation made, and rehabilitation center program completion. Program completion was significantly related to a rehabilitated ("26") closure status. Program completers had significantly higher post-service weekly salaries than voluntary dropouts and persons discharged as non-feasible for services. Notably there was only a 23% match between type of client vocational training received and kind of job accepted based on comparison of first two digit **Dictionary of Occupational Titles** coding for training and jobs. The most successful prediction of center completion for the 1974 sample was a recommendation to long-term evaluation (38% accurate), the most successful predictor for the 1977-1978 sample was a recommendation to direct training (44% accurate).

APPLICABILITY: Results of this study suggest tenure in the center is most predictive of future employment and quality of employment. Results also suggest that diagnostic effectiveness might be improved by shifting from recommendations to specific types of vocational training to isolating potential program noncompleters from completers.

188 Refinement and Evaluation of a System for Weighted Case Closures

Principal Investigator:	Paul G. Cooper, M.S.	
Status:	Continuing	
Dates:	October 1977-March 1980	
Cost:	Annual \$110,102 RT Annual \$27,700	Projected Total \$276,000 RT % of Annual Total 25%
Annual Report Reference:	#14, Page 326, R-170	

OBJECTIVES: The overall purpose of the project is to refine and evaluate the outcome measurement/weighted case closure system currently used by the Arkansas Division of Rehabilitation Services. This refined system may then be used by RSA and/or state rehabilitation agency policy makers and program developers as a model for the eventual implementation of a national weighted case closure system. Information regarding the current Arkansas system clearly indicates that immediate and extensive evaluation of the system as it now exists would be counter-productive. Thus the approach to be used by this project includes a historical review of the Arkansas system and an update of the current state-of-the-art incorporating input from rehabilitation professionals having knowledge of weighted case closure systems, rehabilitation counselors and supervisors who have personally worked under the Arkansas system, and a representative from the Arkansas Consumer Advisory Council for Rehabilitation Services.

There are five specific project objectives:

1. Describe and evaluate the current Arkansas system for client outcome assessment and weighting case closures (ASOM - Arkansas Service Outcome Measure).
2. Update the literature review and state-of-the-art relative to weighting case closures.
3. Refine the Arkansas Service Outcome Measurement instrument and the system for its utilization and interpretation.
4. Implement and evaluate the refined instrument and utilization system.
5. Analyze data and disseminate findings.

METHODOLOGY: Objective 1 calls for the description and evaluation of the current ASOM system. Two basic techniques were used to collect the information required for reaching this objective. The first technique was a structured interview which will be the basic tool for acquiring input from Arkansas Division of Rehabilitation Services personnel regarding the actual day-to-day operation of the ASOM system. The second technique used was the review of agency reports and research studies based on the analysis of ASOM system data.

The combination of these two techniques provided a broad base of information relating to the actual operation of a weighted case closure system as well as its utility and interpretability for agency policy makers and administrators. This information formed a major source of input for the refinement of the ASOM system.

Objective 2 calls for an update of the current state-of-the-art relative to weighted case closure systems. Four basic techniques were used to collect the information necessary for this update. First, the current literature relevant to the topic was reviewed and its application to the present problem summarized.

The Technical Assistance Group (TAG) is the second basic technique used for the state-of-the-art update. The project investigators personally interviewed a resource group consisting of approximately 25 persons with practical knowledge regarding the implementation or design of weighted case closure systems.

The current ASOM instrument and system was refined as part of Objective 3. This refinement effort

took place in four phases. First, the investigator modified the current ASOM instrument in accordance with suggestions derived from the structured interviews of state agency personnel, input from the PAC, and suggestions from the TAG. This modification included changes in form, content, and reporting procedures. Second, a program of training the use of the instrument was developed. Third, the instrument and training program were pilot tested using the counselors on the Agency Advisory Committee as subjects. Finally, based on feedback from the pilot test participants, both the training program and the new instrument were modified further.

Objective 4 calls for the implementation and evaluation of the refined weighted case closure system. The implementation phase proceeded using the usual Arkansas DRS procedure for such new programs. That is, all counselors and supervisors will be trained in area meetings prior to initiating data collection.

The final objective, 5, consists of the dissemination of project findings. Since it is anticipated that the demonstration of a feasible and interpretable system for weighting case closures would have relatively wide appeal, a fairly extensive dissemination effort is planned. First, reports made to the PAC, thus providing feedback to RSA, CSAVR, the Arkansas agency, and the Consumer Advisory Council. Second, presentations will be made to the administrators of the Arkansas DRS and other professional groups. Third, progress reports will be made to the supervisors and counselors of the Arkansas agency in the form of interim presentations to area meetings. Fourth, a final report will be completed. Fifth, journal articles will be prepared giving results of specific project activities. Finally, training packages in the use of the caseload weighting system will be prepared.

FINDINGS TO DATE: This is not applicable since R-170 is a development project.

APPLICABILITY: The overall objective of this project is to refine, demonstrate, and evaluate a weighted case closure system. In reaching this objective, two specific benefits will be realized. First, the project will result in an up-to-date synthesis of theoretical knowledge and practical experience relating to weighted case closure systems. Second, the project will result in a system whose origin and conception resulted from state agency need. This system will have been refined using methodologically sound research principles and will have been demonstrated and evaluated on a full-scale basis within a state agency. Should this evaluation prove favorable the system may serve as a model for other agencies wishing to implement a weighted case closure system.

The products of this project are designed primarily for the consumption of rehabilitation policy makers and program developers. That is, the system to be refined and evaluated will serve as a guide, to those in authority, for the implementation of a weighted case closure system. These policy makers and program developers may be either national or state level professionals. The implementation of any weighted case closure system will affect the evaluation of individual rehabilitation counselors, hence it must necessarily affect their motivation for quality performance. Since one of the purposes of any weighted case closure system is to give differential "credit" for the successful rehabilitation of "difficult" and "easy" cases, those counselors working primarily with severely disabled clients should see their efforts more equitably rewarded.

The products of this research will form a basis for continued investigation, refinement, and demonstration of weighted case closure systems. It is anticipated that the refined system resulting from the project may serve as a model for other agencies. Thus the products of this project may be utilized directly by state vocational rehabilitation programs as well as indirectly by other researchers wishing to further refine the state-of-the-art for weighting case closures.

189 Statewide Field Testing of a Case Movement Model in a Vocational Rehabilitation Agency

Principal Investigators:	Paul Cooper, M.S. Stephanie Davis, M.S.
Status:	New
Dates:	October 1978-December 1980
Cost:	Annual \$767 RT Annual \$491 Projected Total \$15,000 RT % of Annual Total 64%
Annual Report Reference:	#14, Page 298, R-171

OBJECTIVES:

1. To improve case monitoring capability and practice in state vocational rehabilitation agencies.
2. To improve state agency capabilities for the development of relevant planning information.
3. To demonstrate the utility of case movement modeling as a tool for planning and resource allocation in state rehabilitation agencies.
4. To investigate and compare alternative approaches to modeling case movement.

METHODOLOGY: The tasks necessary for successful completion of this proposed project fall into two general categories—Development of a data collection and retrieval system and Data Analysis.

1. **Development of a data collection and retrieval system:** The data collection procedures were to be incorporated into the system changed resulting from another state research and demonstration project for the field testing of a case weighting system (R-170). The data collected consisted of detailed status change information on all clients in Arkansas Division of Rehabilitation Services after July 1, 1979. This entailed modifications in the state client data system, master list update procedures, and client data recording formats. Since the project for field testing the case weighting system has similar data requirements, these system modifications resulted from efforts on that project.
2. **Data Analysis:** Two specific approaches to case movement modeling were investigated. First, the Markov modeling approach developed as part of R-153 was further tested. Second, a Monte Carlo simulation of case movement was designed and compared to the Markov modeling approach. This effort required sophisticated computer programming by R&T center staff but required no additional data over that necessary for the Markov modeling approach.

FINDINGS TO DATE: The results of this project indicate that both Markov modeling and simulation are computationally feasible techniques for describing case movement in a rehabilitation system. Complete results are documented in a dissertation by Ms. Stephanie Davis entitled "A Comparison of Markov and Simulation Models of Case Movement in a Vocational Rehabilitation Agency" which is available from the Arkansas Rehabilitation Research and Training Center as a research report.

APPLICABILITY: The strong effect of federal/state policy on case movement is clearly illustrated by the change in federal regulations which dictated a higher proportion of severely disabled clients on state caseloads. According to the 1976 and 1977 RSA report of caseload statistics, this influx of more severely disabled clients into the system is partly responsible for a decline in rehabilitation rate. It is also suggested that policy requiring new administrative duties by counselors has produced a decline in the number of new cases (U.S. Department of Health, Education and Welfare, 1976). This effect was accentuated by insufficient increases in funding levels which did not offset inflationary trends (U.S. Department of Health, Education and Welfare, 1977).

Through the development of a viable model of case movement in the rehabilitation system, more accurate predictions of case flow characteristics may be made for projected changes in federal or state policy. For example, if such a model had been available prior to the Rehabilitation Act of 1973, administrators might have had a more accurate picture of the results of an increased emphasis on severely disabled clients so that services to this group might be expanded more efficiently. Suppose an outreach effort is designed to produce 10% more clients per year. The results of this effort with respect to case movement may be predicted through the use of a viable case movement model. Likewise, such a model could be used to predict the long term ramifications of a decrease in the number of accepted clients. In summary, a viable and tested case movement model may be used to predict changes in certain case flow characteristics induced by changes in policy or services provided.

190 A Comprehensive Follow-Up of Arkansas Rehabilitation Clients Served by the Hot Springs Rehabilitation Center, 1966-1978

Principal Investigator: Daniel Cook, Ph.D.
Status: New
Dates: October 1978-June 1981
Cost: Annual \$5,367
RT Annual \$3,435
Projected Total \$130,000
RT % of Annual Total 64%
Annual Report Reference: #14, Page 308, R-172

OBJECTIVES:

1. To review the literature on follow-up studies with regard to formulating questionnaire items with the greatest generalizability.
2. To develop a questionnaire/telephone procedure to assess current client psychosocial adjustment.
3. To conduct a full-scale follow-up study and relate current psychosocial and vocational adjustment to the type of service received by the client population:
 - a. over 450 spinal cord injured clients referred to Arkansas Rehabilitation Services,
 - b. over 2,500 clients who received services at the Hot Springs Rehabilitation Center 1966 to 1968, and
 - c. approximately 300 mixed disability clients enrolled at the Hot Springs Rehabilitation Center 1977-1978.

METHODOLOGY: The research design consisted of developing sample survey techniques (e.g., rolling random selection of clients from a population), telephone interviewing, and trace back methods to locate clients discharged from rehabilitation services.

FINDINGS TO DATE: Review of the follow-up literature has been completed. Data on former clients enrolled at the Hot Springs Rehabilitation Center during 1966 through 1968, is being collected and analyzed.

APPLICABILITY: Follow-up studies are a federally mandated evaluation activity. However, follow-up studies present formidable methodological problems not addressed by legislated evaluation standards. Results will provide information on improving client service delivery.

191 Development and Evaluation of a Self-Report Instrument to Assess Basic Life Skills: The Psychosocial Development Matrix Questionnaire

Principal Investigator: Robert L. Akridge, Ed.D.
Status: New
Dates: November 1978-October 1979
Cost: Not applicable

Annual Report Reference: New since report #14

OBJECTIVES:

1. To identify and/or construct a set of test items which provide a sample of basic life skills consistent with the model developed in projects R-164 and MD-9 (Psychosocial Development Matrix Questionnaire);
2. to evaluate the utility of the **Psychosocial Development Matrix Questionnaire (PDMQ)** for client assessment and program evaluation in rehabilitation;
3. to evaluate the reliability of the PDMQ;

4. to evaluate the validity of the PDMQ;
5. to develop normative PDMQ data for the general population and for particular disability groups (after acceptable reliability and validity is established).

METHODOLOGY:

1. Have a group of Adjustment Specialists rate each item for content validity;
2. administer the instrument to a large number of handicapped individuals and non-handicapped individuals to establish norms;
3. conduct factor analysis and item analysis to ascertain internal consistency and construct validity;
4. correlate PDMQ factor scores with other related instruments to establish concurrent validity and construct validity; and
5. conduct discrimination studies to determine the power of the PDMQ to discriminate between well defined groups (disability groups, treatment groups, diagnostic groups, etc.).

FINDINGS TO DATE: Rehabilitation administrators, counselors, and adjustment specialists were generally in high agreement in endorsing the content validity of the PDMQ items.

About 400 data sets have been collected and arrangements have been made with institutions and agencies for collecting the remaining data.

Several validity studies have been conducted as an adjunct to collecting basic norm data. Some of the correlational analyses with other instruments include: The Human Service Scale, Rosenberg's Self-esteem scale, Rotter's I.E. Scale, and client behavior rating scales on the following dimensions: self-directive, self-revealing, internalization/externalization. Four prediction studies were conducted using individual PDMQ items as multivariate predictors of group membership. The instrument was a very powerful predictor of the following: (a) disability groupings, (b) competitive, non-competitive, or no work experience, (c) appraising one's financial status as high, middle, or low, and (d) a four-way typology made up of high or low self-evaluation on self-report inventories and high or low performance (evaluation by others).

APPLICABILITY: Rehabilitation has been a leader among the Human Service professions in developing a skills training approach to helping people. Too often, however, the available assessment technology still emphasizes a traditional "medical model" approach which serves to establish eligibility but fails to provide information which is useful for developing client programs. The PDMQ items represent intermediate objectives for programs in the psychosocial domain.

192 Evaluation of the Effect of Behavioral Consultation Within A Comprehensive Rehabilitation Center

Principal Investigators: John N. Marr, Ph.D.
Suki Hinman, M.A.

Status: New

Dates: January 1979-August 1980

Cost: Not applicable

Annual Report Reference: New since report #14, R-174

OBJECTIVES:

1. To place a consultant inside a large comprehensive rehabilitation facility to facilitate change in service delivery procedures. Consultation objectives:
 - a. To teach staff in evaluation to identify and specify deficit and surplus behaviors of Rehabilitation Center clients.
 - b. To teach Center counselors to write, on the basis of the behavioral descriptions from the evaluators, interviews with the clients, and information from the field counselors, individual

rehabilitation programs which include specific behavioral objectives for each student.

- c. To teach staff in those service sections who have identified a need for training, a course in interpersonal facilitation which will include methods of increasing attractiveness of the staff as secondary reinforcers and methods of effectively decreasing behaviors that impede rehabilitation progress.
 - d. To consult with staff in work adjustment and vocational training areas on identification of behavioral surpluses and deficits, on methods of shaping and chaining to accomplish vocational goals, and on methods of extinction, overcorrection, and contracting to decrease behaviors impeding vocational training.
2. To evaluate the effectiveness of the consultation activities.

METHODOLOGY: A letter of agreement between the administrator and principle investigator was written assigning the consultant to him as a staff member who would receive supervision from the principle investigator only for research purposes. Priorities of consultation were listed as in Objective 1a-d above.

Individual Written Center Plan (IWCP) forms were developed and evaluators and counselors are being taught to write specific behavioral descriptions and objectives for each student. A multiple-baseline-across-staff design is being used to evaluate the effectiveness, the number of behavioral descriptions and objectives being counted for each counselor at 2 month intervals from the beginning of the study. Each counselor is taught the procedure individually with two counselors beginning training approximately every third week.

To assess the effect of training medical and dormitory staff methods of improving interpersonal facilitation with students, three measures are being taken. (1) A pre and post measure of social climate is being administered within each dormitory, (2) each nurse and houseparent is being observed on the job for two hours and rated on relevant behaviors before and after training, and (3) fourteen clients, representing seven dormitories, were taught to record every half hour (using pocket timers) personal interactions with staff once a week for five weeks prior to staff training, during the 12 weeks of training, and will continue for 10 weeks following training. These clients are called AID workers (An Interpersonal Diary) and were pre-trained to .90 accuracy.

The consultant was further instructed to respond to all other requests for assistance by the staff that were relevant to the behavioral consultation mission.

FINDINGS TO DATE: Over 40% of the counselors have been trained individually to write IWCPs with behavioral descriptions and objectives. Unsolicited reactions of field counselors have been very favorable and requests for similar training of field counselors have been received. The frequency measures of behavioral descriptions and programs are being developed.

AID workers have proved to be able to rate interpersonal interactions with staff reliably and in an unobtrusive manner.

Other requests for behavioral consultation that developed as a result of the work within the Center were:

1. Teaching houseparents to analyze dormitory disturbances in terms of behavioral analyses: antecedents, specific behaviors, responses of houseparents to the behaviors and any other consequences.
2. A modified overcorrection procedure in written form was developed to reduce the number of dormitory keys lost weekly. The procedure has already decreased loss of keys by 60%. A similar procedure designed to reduce the number of meal cards lost monthly is now being implemented.

APPLICABILITY: The placement of a behavioral consultant within a rehabilitation facility as a staff member who concentrates on developing new programs, training staff, and responding to behavioral needs of staff should serve as a demonstration of the effectiveness of types of training of staff while on the job, the effectiveness of using client workers in research, and the effectiveness of various behavior management procedures developed to fit the specific needs of the Center.

193 A Comprehensive Investigation of the Vocational Abilities and Motivational Characteristics of Rehabilitation Clients

Principal Investigator: Brian Bolton, Ph.D.
Status: New
Dates: March 1979-June 1982
Cost: Not applicable
Annual Report Reference: New since report #14, R-175

OBJECTIVES: The following broadly stated objectives were formulated to delineate a comprehensive description of the psychological variables that are central to understanding the vocational behavior of rehabilitation clients. The ultimate purpose of this investigation is the generation of a knowledge base upon which vocational guidance strategies can be premised.

1. To construct norms for rehabilitation clients for standardized instruments that measure various aspects of the work personality, e.g., intellectual capabilities, work values, vocational interests, psychomotor skills, etc.
2. To compare subsamples of clients, e.g., by disability, age, sex, educational level, etc., in order to isolate the background characteristics that impede or accelerate the vocational adjustment of disabled clients.
3. To analyze the structural complexity of the various domains of the work personality, e.g., intellectual, interest, values, etc., to quantify the extent of differentiation that has occurred and make comparisons to nondisabled populations.
4. To analyze the intellectual characteristics of disabled clients and examine the interrelationships between intellectual functioning and other aspects of the work personality.
5. To analyze the interrelationships between psychosocial adjustment and vocational development, especially as reflected in appropriate work values. While it has long been recognized by rehabilitationists that restricted vocational development may impede the rehabilitation process, it is not known to what extent vocational immaturity is confounded with difficulties in psychosocial adjustment.
6. To analyze the relationships between the major dimension of rehabilitation clients' work personalities and their rehabilitation outcomes, i.e., closure status, occupational level, salary, etc.
7. To analyze the relationships between the major dimensions of rehabilitation clients' work personalities and their vocational adjustment, i.e., job satisfaction and satisfactoriness as measured by the Minnesota Survey of Employment Experiences.
8. To outline the implications of research on the vocational behavior of disabled clients for rehabilitation counselors.

METHODOLOGY: In conjunction with the Arkansas Rehabilitation Service's RIDAC Project (see R-169) more than 2,000 applicants for services received some form of evaluation. One or more of the following evaluations were received: medical, psychological, psychiatric, vocational, and General Aptitude Test Battery. The psychological and vocational evaluations include the administration of tests and inventories of especial relevance to the assessment of the work personality of disabled persons. Approximately 1,200 clients received psychological evaluations that measure work values and occupational interests.

The instruments that were administered as part of the RIDAC evaluation or will be administered in conjunction with the follow-up phase of the investigation are classified according to the common elements in the models of vocational behavior proposed by Gellman and Hershenson.

Background: Standard demographic data such as sex, age, education, disabling condition, work status, etc., is routinely collected on the R-300 form.

Work Personality and Competencies: Two classes of instruments were used (a) abilities (or measures of maximum performance) and (b) work motivation (or measures of typical performance). The Wechsler Adult Intelligence Scale (WAIS) is the standard clinical instrument for the assessment of intellectual functioning. Using 11 subtests, a variety of verbal and performance skills are tapped.

The Purdue Pegboard provides a reliable measure of the major components of manual dexterity and hand-eye coordination. Two projective techniques were employed to assess brain damage and personality integration, the Bender-Gestalt and the Draw-A-Person. A special form of the Sixteen Personality Factor Questionnaire (16PF-E) was used to quantify the primary dimensions of normal personality functioning. The Work Values Inventory (WVI) and the California Occupational Preference Survey (COPS) provided multi-dimensional profiles of these two important aspects of the work personality. The General Aptitude Test Battery (GATB), Minnesota Clerical Test (MCT), and Bennett Test of Mechanical Comprehension were administered on a selective basis.

Vocational Choice and Placement: Information concerning job placement, occupational level, salary, etc., is available on the R-300.

Work Adjustment: The Minnesota Survey of Employment Experiences measures job satisfaction, satisfactoriness, and collect detailed information about clients' employment situations.

FINDINGS TO DATE:

1. The Assessment of Vocational Motivation of Physically Disabled Clients. The assessment of vocational motivation is a concern that is central to the primary goal of the vocational rehabilitation process. An analysis of the Work Values Inventory (WVI) profiles of 445 physically disabled clients revealed that (a) They are motivated by intrinsic as well as extrinsic values, (b) their work values are independent of age, education, and intelligence, and (c) their profiles of work values provide relatively unique information for counseling purposes. Three approaches to the interpretation of the WVI that may be used by the rehabilitation counselor are outlined: the normative strategy, the individualized strategy, and the predictive strategy. It was concluded that the WVI is a potentially useful instrument for assessing the vocational motivation of physically disabled clients.
2. Second-Order Dimensions of the Work Values Inventory (WVI). An item factor analysis of the 45 items of the Work Values Inventory for 445 physically disabled clients produced six second-order dimensions: Meaningful Work, Interpersonal Satisfaction, Economic Security, Responsible Autonomy, Comfortable Existence, and Esthetic Concerns. These second-order factors provide a summary of clients' work motivation at a higher level of generality that is consistent with the WVI primary structure. The six factors are virtually independent of age, education, and intelligence and can be hand-scored by a simple procedure.

APPLICABILITY: The results of the investigation will have direct implications for the vocational guidance of disabled clients, especially regarding the use of adjustment services, vocational training, and job placement.

194 The Contribution of Personal Achievement Skills (PAS) to Work Adjustment Training: A Replication and Extension

Principal Investigator:	Richard T. Roessler, Ph.D.
Status:	New
Dates:	April 1979-February 1980
Cost:	Not applicable
Annual Report Reference:	New since report #14, R-176

OBJECTIVES:

1. To replicate the results of a previous study of the contribution of PAS to work adjustment (R-135).
2. To extend the evaluation of Personal Achievement Skills to assessment of the skill development of rehabilitation clients.
3. To implement the training as a regular feature of the work adjustment program at Woodrow Wilson Rehabilitation Center if results of the study are promising.

METHODOLOGY: A random sample technique was used to assign 24 clients to one of three Personal Achievement Skills groups (8 per group) and 8 clients to regular work adjustment services. All clients were selected from the current roster of clients enrolled in the work adjustment program at

University of Arkansas

Woodrow Wilson. Both groups were pre and post-tested over a period of twelve weeks by graduate students in psychology from James Madison University (Harrisburg, VA.) Under the supervision of the Director of Psychological Services at Woodrow Wilson Rehabilitation Center.

Three teams consisting of a leader and co-leader, both of whom are instructors on the work adjustment staff or members of the Psychological Services Department, conducted three PAS groups, three days a week for one and one-half hours each session, over a 12-week period. All leaders and co-leaders were trained prior to the start of this program by Arkansas Rehabilitation Research and Training Center faculty.

Outcome criteria for the evaluation include the following:

1. The Carkhuff Scales (Interpersonal Communications) (Carkhuff, 1976).
2. The Means-Ends Problem Solving Measure (Platt & Spivack, 1975).
3. Rosenberg's (1965) Self-Esteem Scale.
4. The Goal-Setting Interview.
5. Cantril's (1965) Life Ladder Measure.

Pre and post-testing of clients followed a structured interview approach interspersing the skill measures with the self-perception measures. Interviewers were trained to conduct the procedure by members of the research team and practiced the procedure with rehabilitation clients before beginning pre-test interviews. Interviews with experimental and control clients were conducted on a scheduled basis which was approved by the Woodrow Wilson Rehabilitation Center. During both pre and post-testing sessions interviewers did not know the group membership of the clients.

FINDINGS TO DATE: In February, 1979, the Personal Achievement Skills Training with students began in the work adjustment center. The research study required that four groups be selected at random from students currently enrolled in the work adjustment center. Three of these groups were experimental groups ($n=8$), and one group was a control group ($n=8$). The three experimental groups represented different levels of intelligence with group one having the lowest intelligence (IQ=52-61); group two, moderate intelligence (IQ=62-74); and group three, higher intelligence (IQ=75-97).

Since only 32 students were available for the study, the experimental and control groups were smaller than planned. Initially, 50 students, all with an IQ above 70, were to be involved in the study. However, enrollment patterns in work adjustment resulted in a large proportion of the participants having a lower IQ than usually recommended for PAS training. In the past, it has been suggested that an IQ of 70 be a cutoff for Personal Achievement Skills Training.

Client gains were assessed in each of two skill areas, problem-solving (Platt & Spivack, 1975) and interpersonal communication (Carkhuff, 1976). Based on the results of the study, students in the Personal Achievement Skills groups gained no more in either of these areas than did the control students. Since all participants responded at both pre and post-testing with one to two methods for resolving problems presented in the problem-solving measure, it can be concluded that PAS training did not result in improved problem-solving skills.

A similar lack of effect was found with the interpersonal skills measure administered in the study. At both pre and post-testing, students in the trained and control groups responded with level 2.0 responses on Carkhuff's (1976) nine point scale. The level 2.0 response is basically an accurate response to the content of a statement with no reference to the feeling. Trained students were expected to be more sensitive to the feeling element of communication as a function of participating in Personal Achievement Skills Training.

Over the course of the study, participants in both the trained and control groups retained a moderate level of self-esteem. No statistically significant gains were reported from a previous PAS study with rehabilitation clients (Roessler, 1978). Similarly, no significant changes were noted for the trained groups on the Self-anchoring Life Ladder. As mentioned in the pre-test profile, the trained and untrained groups at both pre and post-testing tended to report a positive outlook with five years in the future being closer to their best possible life than either their status now or their status five years in the past. Previous research reported gains in life outlook for rehabilitation clients (Roessler, Cook, & Lillard, 1976) in PAS training.

Consistent with other studies of Personal Achievement Skills, statistical trends toward a treatment effect as measured by two self-report measures of goal-setting were found. In essence, results on the goal-setting measures indicated that participation in Personal Achievement Skills seems to facilitate goal attainment on the part of rehabilitation clients.

Several more impressionistic evaluations of Personal Achievement Skills were completed. Group leaders assessed the training experience positively and enjoyed using the program with students. Written student evaluations regarding PAS echoed the positive perceptions reported by the staff. A large majority of students (over 90%) indicated that they felt the program was beneficial, that they would participate in a similar group, and that they would recommend such a group counseling program to a friend.

The following recommendations for future use of Personal Achievement Skills resulted from this study:

1. Reexamine the applicability of the PAS approach for training individuals with lower IQ's.
2. Provide staff with more intensive training in Personal Achievement Skills Training focusing on not only course content but also on the techniques of self-control of behavior, goal setting, and interpersonal skills.
3. Provide staff with release time to conduct the PAS program.
4. Evaluate the appropriateness of the measures of psychosocial gain, and
5. Provide more ongoing training support from RT-13 during the course of the PAS sessions.

APPLICABILITY: Rehabilitation of individuals with disabilities includes not only vocational but also prevocational training. As a prevocational training approach, Personal Achievement Skills has demonstrated in several rehabilitation settings its positive effect on client self-perception. This study not only sought to replicate PAS' effect on self-perception but also to estimate the training's effect on client communication, problem-solving, and goal-setting skills.

195 Psychological and Environmental Correlates of Successful Completion of Vocational Training in a Comprehensive Rehabilitation Center

Principal Investigator:	Richard Roessler, Ph.D.
Status:	New
Dates:	April 1979-March 1981
Cost:	Not applicable
Annual Report Reference:	New since report #14, R-177

OBJECTIVES:

1. To identify those factors which distinguish between clients who make good progress in vocational training at a comprehensive vocational rehabilitation center and those clients who make poor progress.
2. To suggest psychosocial, evaluation, and training strategies for increasing client success in vocational training.

METHODOLOGY:

1. Conduct a structured interview with 50-60 Hot Springs Rehabilitation Center students who have an Individualized Written Center Plan soon after evaluation's recommendation that they move directly to vocational training (April-December, 1979).
2. Obtain counselor and instructor rating of work adjustment (amount of supervision required, realism of job goals, teamwork, acceptance of rules/authority, work tolerance) and global rating of progress in training (July, 1979 to February, 1980).
3. Conduct second structured interview with those making good progress and rated high on work adjustment and those making poor progress and rated low on work adjustment to determine

effect of vocational training experience and reasons for good or poor progress (August, 1979 to February, 1980).

4. Monitor student progress in Center and with field counselor (December to July, 1979-80).
5. Conduct phone interviews with Center dropouts to determine current status and reasons for dropping out of training (July, 1979 to May, 1980).
6. Complete data analysis, report writing, and proposal development based on implications of study for further research and training efforts.

Variables:

Person: Personal competency: IQ, Problem-solving, Social competence. Personal Constructs: Perceived job discrimination. Expectancies: Degree of confidence in ability to succeed in work. Values: Acceptability of welfare as a source of financial support.

Environment: Stressful life events occurring outside the Center. Center-specific problems. Financial disincentives to work.

APPLICABILITY: Information from the study may have direct relevance to the evaluation, selection, and preparation of clients for vocational training in comprehensive rehabilitation centers. Findings will also be of considerable interest to other rehabilitation professionals involved in the areas of work evaluation, personal adjustment training, and vocational training.



**West Virginia University (RT-15)
Vocational Rehabilitation Research and Training Center**

CORE AREAS

Program Evaluation

Techniques and strategies to improve the capacity of vocational rehabilitation in program assessment and evaluation, and data management and utilization to increase the effectiveness of the rehabilitation program in meeting the needs of those it serves.

Improved Service Models

Investigating various aspects of the vocational rehabilitation system with the aim of providing information and models which will permit rehabilitation to increase the effectiveness of its services and service delivery system.

Programmatic Barriers to Vocational Rehabilitation

Identification and assessment of all types of program barriers to vocational rehabilitation at all levels, e.g., state and national.

Affirmative Action and Consumer Involvement

Strategies and techniques for enabling vocational rehabilitation of handicapped individuals for maximizing the impact of legislation leading toward total integration of handicapped into the world of work.

Institute on Rehabilitation Issues

The study of significant issues of concern to the rehabilitation community.

WEST VIRGINIA UNIVERSITY

Joseph B. Moriarty, Ph.D., Director
West Virginia University Vocational
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Institute, West Virginia 25112

COMPLETED

ABSTRACT NO.

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Improving and Evaluating Job Skills Training	
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The Sheltered Workshop as a Waste Recycling Center: A Work-Adjustment Program for Severely Disabled Clients	
A Study of the Impact of an Interactive Data Analysis System on State Agency Program Evaluation Functioning	

196 Program Evaluation and Planning (Tools for Rehabilitation)

Principal Investigator:	Richard T. Walls, Ph.D.	
Status:	Completed	
Dates:	March 1973-December 1978	
Cost:	Annual \$26,895 RT Annual \$18,221	Projected Total \$90,000 RT % of Annual Total 68%
Annual Report Reference:	#13, Page 21, R-24	

OBJECTIVES: To develop a model for evaluation of rehabilitation services. (The research activity is attempting to show the extent to which coded R-300 data may be used to evaluate rehabilitation services.) The major question is (a) what data elements or variables, (b) what data collection aids, and (c) what data reduction or display techniques will be of greatest value to VR agencies?

METHODOLOGY:

1. The project examined the records of over 700,000 rehabilitation clients with all types of handicaps.
2. Various variables (demographic, educational, social, economic, disability, process, closure, cost-benefit, outcome, client rated) were studied.
3. The Profile Analysis Technique was developed and field tested.

FINDINGS TO DATE: Meetings and final selections of the 15 PAT elements were completed in November, 1976. The state agency then approved these elements for the profile. Safeguards were built in to insure confidentiality.

To address the problem of interpretation of special counselor caseloads, four transparent layovers were computed and constructed to represent the average caseload profile of all counselors of the blind, all counselors of the deaf, all homemaker counselors, and all trust fund counselors in the state. By super-imposing the transparent layover on the counselor's profile, one could readily note relative positions of that counselor to the state average of all counselors in this state (basic PAT profile) as well as to the average of all other special counselors of that type in the state (the transparent layover).

A conceptualizing manuscript was completed entitled, "The Caseload Profile: An Alternative to Weighted Closure" by R.T. Walls, and J.B. Moriarty (1977). This paper was published more recently in **Rehabilitation Literature**. This manuscript is available as additional clarification and documentation on request.

A manual of approximately 140 pages was completed for counselors and supervisors. This manual is entitled, "Profile Analysis Techniques: A Reference Text" by J.B. Moriarty and R.T. Walls and edited by A.H. Randolph. This manual is available as additional clarification and documentation on request.

APPLICABILITY: The Caseload Profile employs a device termed the profile analysis technique (PAT). There are five major guiding criteria in the development of this PAT mechanism. These were (a) orientation toward rehabilitation, (b) multiple criteria analysis, (c) flexibility, (d) simplicity in computation, and (e) ease of interpretation. The essential idea is that information routinely collected by state agencies may be used to compare an agency's, district's, or individual's performance in a number of categories against a norm (e.g., national, state, or district average).

197 Analyzing Performance Competencies of Severely Handicapped Clients

Principal Investigator: Richard T. Walls, Ph.D.
Status: Continuing
Dates: May 1976-April 1980
Cost: Annual \$26,917 Projected Total \$76,000
RT Annual \$18,443 RT % of Annual Total 69%
Annual Report Reference: #13, Page 60, R-33

OBJECTIVES: The overall objective and purpose of the study is to determine which skills clients need to learn to be placed in and survive in competitive employment. More specifically the objectives of the present design are:

1. To construct a matrix of vocational skills, taking into account skills proposed by the vocational behavior checklists currently in use nation-wide.
2. To add skills as necessary to fill gaps and allow comprehensive vocational assessment and training of VR clients.
3. To determine reliability (a. stability and b. interobserver) and validity (a. content and b. criterion related) of **The Vocational Behavior Checklist** skills matrix.
4. To train 20 work adjustment or training specialists in the use of **The Vocational Behavior Checklist**.

METHODOLOGY: In an attempt to determine the number of behavior checklists available and in use, an advertisement was placed in several periodicals requesting "... behavior checklists used in tabulating behaviors of skills" of various populations. The same request was sent to a number of individuals as well as to 883 state schools and rehabilitation facilities.

We received more than 200 checklists in return from individuals, facilities, and training programs. These lists varied widely in the extent to which they represented carefully specified and observable behaviors. Further, the item formats and scoring requirements differed markedly. In addition, while some were concerned with only one or two classes of behavior, others included behaviors in fifteen or more classes. Each of these classes of behavior might contain only a few specific behaviors or a hundred or more specific behaviors representative of that class. Some classes of behavior commonly represented in these checklists were: eating, toileting, dressing, health, grooming, communication, mobility, dexterity, vocational, recreational, socialization, orientation, motor skills, self-help, daily living, independence, alcohol or drug use, household, and work skills. Of the more than 200 checklists, 166 of them have been reviewed in an annotated bibliography (Walls, Werner, Bacon, and Zane, 1977).

FINDINGS TO DATE: All of the items related to the assessment of vocational behaviors were reviewed and evaluated. Although these classes of skills were sometimes labeled "Prevocational," "Occupational," "Job," or "Work" behaviors, any items associated with employment were considered to be in the broad "vocational" classification. Vocational items from 21 checklists were sorted into seven categories, and overlapping or duplicate items eliminated. These seven categories are Prevocational Skills, Job Seeking Skills, Interview Skills, Job Related Skills, Work Performance Skills, On-the-Job Social Skills, and Union-Financial-Security Skills.

All of the items that were retained were used to guide the writing of the present 343 behavioral definitions (skill objectives) to include **conditions** of performance, specific **behaviors**, and **standards** of performance. In almost all cases this rewriting and modification was extensive, since many of the checklists used only a short phrase to describe each behavior and/or did not include conditions and/or did not include standards. Further, many gaps were filled by creating completely new items. Many new skill objectives were derived from our work with vocational rehabilitation clients in sheltered workshops, deinstitutionalization training, rehabilitation facilities, and field based vocational rehabilitation programs.

APPLICABILITY: Results of the experiment and training based on the experiment should be of greatest benefit to training supervisors and VR counselors. The ultimate benefactor is the client. Compre-

hensive vocational skills assessment can help all parties to effective placement. Behavioral statements of skills are not as likely to be misinterpreted as scores on trials, constructs, rating scales, or global objectives.

Further, the findings of this project may be utilized by vocational rehabilitation personnel who must observe, evaluate, and improve client performance. Since vocational rehabilitation services address themselves to a wide variety of client activities, this project will provide a useful function in organizing available performance checklists in terms of activities relevant to getting and keeping a job.

198 Negative Incentives: Contingencies which Discourage Disabled Individuals from Seeking or Completing Rehabilitation Services and Subsequent Employment

Principal Investigator:	Richard T. Walls, Ph.D.	
Status:	Continuing	
Dates:	May 1976-April 1979	
Cost:	Annual \$8,928 RT Annual \$5,870	Projected Total \$18,000 RT % of Annual Total 66%
Annual Report Reference:	#13, Page 114, R-34	

OBJECTIVES: The major question is which types and amounts of cash and in-kind benefits (at what benefit-loss rate) discourage eligible individuals from engaging in and completing VR services. Further, to what extent is this a problem in VR, and, if it is a substantial problem, what are some possible remediating actions?

METHODOLOGY: Subjects. The subjects are 304 potential VR clients of varying age, sex, and disabling conditions. Of these persons, some were receiving some kinds of cash and/or in-kind benefits at referral to VR. The others were receiving benefits from any of the sources at referral.

Design. The design is a simple two group format. The clients receiving benefits at referral are considered the experimental group and the clients not receiving benefits at referral are considered the contrast or control group. The independent variable is, thus, benefits at referral versus no benefits at referral. Obviously, the amounts and types of benefits vary markedly within the experimental group since no attempt to stratify the random sampling procedure was attempted. This implies blocking on different patterns or clusters of disability, sex, age, or most importantly, type and amount of benefits will probably aid in clarifying the findings. However, the major result will consist of a comparison of frequencies of successful closures for the experimental versus control group. Thus, the dependent variable is the closure status of the individuals. Factors associated with closure such as competitive employment, homemaker employment, earnings, etc. will also be considered.

Since a final report on the major question will not be completed until Summer 1980, this is simply an interim report of some of the relations determined from the initial data collection. No relations between benefits and VR closure are reported herein.

FINDINGS TO DATE: Interim findings. The interviewers surveyed as many potential VR clients as possible without prior knowledge of whether or not the person had any benefits (180 males and 124 females, 117 in WV and 187 in MD). The interviewers were not selective and took all clients coming through a particular field office as time permitted. Since 208 of the potential clients had some benefits and 96 did not, approximately 68% of VR clients (at least as represented by this sample) have some cash or in-kind benefits at initial contact with VR. Of the 208 beneficiaries, 126 were males and 82 were females, 67 in WV and 141 in MD.

Of the 301 for which living environment information was available, 31 (10%) were rural, 45 (15%) were small communities, 26 (9%) were suburban, and 199 (66%) were urban. In West Virginia, 76 (65%) of those clients were from rural or semi-rural settings and 41 (35%) were from urban or suburban settings. In Maryland (Baltimore), 184 (100%) of those clients were from urban, or suburban settings.

Of the 301 for which poverty level information was available, 204 (68%) were below the poverty level, and 97 (32%) were above. In West Virginia, 61 (52%) were below the poverty level. In Maryland, 143 (78%) were below the poverty level.

Of the 300 for which housing information was available, 223 (74%) rent, 53 (18%) own, and 24 (8%) are buying. In West Virginia, 62 (53%) rent. In Maryland, 161 (88%) rent.

Of the 301 for which work history information was available, 150 (50%) had worked for more than 5 years full-time, 43 (14%) had worked less than 1 year full-time, and 46 (15%) had no previous full-time work. Of the 255 who had worked full-time, 221 (87%) had worked in competitive employment and 34 (13%) had worked in sheltered employment.

Of the 208 individuals with benefits, 84 (40%) received benefits from only one source; 70 (34%) received benefits from two sources; 36 (17%) received benefits from three sources; 13 (6%) received benefits from four sources; 4 (2%) received benefits from five sources; 1 (>1%) received benefits from six sources.

The 208 individuals with one or more benefits received an average of \$323 per month from all sources of benefits (total).

The 208 individuals with one or more benefits would lose an average of \$318 per month if they obtained a minimum wage job. A minimum wage job at \$2.65 per hour would yield \$424 per month before taxes and withholding.

In West Virginia, the 67 individuals with one or more benefits received an average of \$351 per month from all sources of benefits (total). In Maryland, the 141 individuals with one or more benefits received an average of \$310 per month total benefits.

In West Virginia, the 67 individuals with one or more benefits would lose an average of \$335 per month if they obtained a minimum wage job. The 141 in Maryland would lose an average of \$310 per month.

The 126 males with one or more benefits received an average of \$353 per month from all sources of benefits (total). The 82 females with one or more benefits received an average of \$278 per month from all sources of benefits (total).

The 126 males with one or more benefits would lose an average of \$349 per month if they obtained a minimum wage job. The 82 females would lose an average of \$269 per month.

The 208 individuals with one or more benefits received an average of \$233 per month from their primary (highest dollar amount) source of benefits.

The 208 individuals with one or more benefits had received some benefits for an average of 26 months prior to agency contact.

Of the 304 potential clients, 46 (15%) were receiving SSDI benefits (36 males and 10 females; 13 in WV and 33 in MD).

The 22 individuals with SSI benefits received an average of \$299 per month.

The 46 individuals with SSDI benefits received an average of \$147 per month.

Of the 304 potential clients, 2 (1%) were receiving both SSI and SSDI benefits.

Of the 22 SSI recipients, SSI was the primary (highest dollar amount) source of benefits for 14.

Of the 46 SSDI recipients, SSDI was the primary (highest dollar amount) source of benefits for 41.

Of the 46 SSDI recipients, SSDI was the only source of benefits for 23.

APPLICABILITY: Theoretically, findings from the study would be of significant social importance. A critical problem facing our legislators today is the establishment of effective governmental assistance programs. A great deal of pressure exists to establish a financial aid system which is helpful and yet equitable. If the findings from this study prove to be of significance, they should guide those who need more than intuition to construct this legislation.

Present policies of financial aid serve as environmental contingencies which serve to influence the actions of those who receive benefits. If the present set of contingencies which exist support

behavior which is detrimental in the long run to either the individual or the assisting agencies in question, it is important to change them.

199 Development of a Valid Multiple - Factor Instrument to Assess Severity of Handicap

Principal Investigator:	Richard Hartnett	
Status:	Continuing	
Dates:	October 1976-April 1980	
Cost:	Annual \$65,617 RT Annual \$51,000	Projected Total \$225,000 RT % of Annual Total 78%
Annual Report Reference:	#13, Page 136, R-35	

OBJECTIVES: The overall objective of this project is to develop, standardize, and validate a practical, cost-effective instrument to measure handicap severity. Such an instrument should ideally yield a profile for an individual that would measure components of handicap severity as follows: (1) degree of handicap in mobility; (2) degree of handicap in self-care; (3) degree of handicap in motivation and psychological independence; (4) degree to which individual perceives problems to exist in personal, social, family, and vocational adjustment; (5) impact of demographic variables on employability; and (6) related factors.

METHODOLOGY: Establishment of a methodology for this study will include the following establishment of a panel of technical consultants, completion of literature search, evaluation of instruments or items for inclusion in a pilot battery, content analysis of resultant items, analysis of pilot inventory by reading specialists, preliminary field test of pilot battery with no less than 30 severely disabled clients, revisions of the inventory, reliability checks, concurrent validity tests, alternative weighting procedures, and form development.

FINDINGS TO DATE: During FY 1979, the researchers engaged in the following tasks related to the intermediate development of the P.D.S.

Sub-scale Construction: Researchers have developed a battery of potential items for inclusion in the seven sub-scales of the P.D.S. As of November 1978, the P.D.S. had undergone nine substantive drafts both on editorial analysis and field testing of the instrument.

In addition to field testing the P.D.S. with VR clients, researchers administered two sub-scales, the Preliminary Estimate of Learning Ability and the Work-Related Knowledge, to undergraduate students at the University during the second semester 1977-78. Sub-scales were then correlated with appropriate intelligence scales.

Researchers devised a scoring system for the P.D.S. and prepared the data for computer analysis. On the basis of preliminary testing and re-testing, the P.D.S. was modified to maximize coverage of the sub-areas, and accommodate item difficulty and scoring exigencies. Also the instrument was re-formatted for readability and other stylistic concerns.

Statistical Techniques: To analyze the content of the various drafts of the P.D.S., sub-scales and items are being statistically analyzed to determine measures of reliability and validity. A point by serial correlation was run on the P.E.L.A. and the Work-Related Knowledge (N=98). Twenty of the thirty items on the P.E.L.A. surpassed the .40 level of correlation; and no items had negative values. On the Work-Related Knowledge, 13 of 18 items were above .40. At the same time, successive field testing of the P.D.S. with center clients and field-office clients is on-going in order to solicit the input of potential users of the instrument. Moreover, the scores on the sub-scales of the P.D.S. will be converted into stanines for the purpose of reporting individual profiles.

APPLICABILITY: Once the multiple-factor instrument has been developed with an accompanying manual to facilitate its use, two forms of the manual will be developed for direct application to rehabilitation. Form A of the manual will be for client-serving personnel, such as counselors and vocational evaluators to aid in documenting eligibility, to sensitize client-serving personnel to

differential needs of individual clients, and to assist in the development of the Individualized Written Rehabilitation Program for each client. Form B of the manual will be oriented toward program evaluators to use as a supplement to number of closures, to help specify agency policy and priorities in terms of intake practice, potentially, and to assess employability gain vs. employment.

200 Factors Influencing Work Adjustment of Disabled Workers

Principal Investigator:	M.S. Tseng, Ed.D.	
Status:	Continuing	
Dates:	May 1976-April 1980	
Cost:	Annual \$40,043 RT Annual \$28,075	Projected Total \$126,000 RT % of Annual Total 70%
Annual Report Reference:	#13, Page 150, R-36	

OBJECTIVES:

1. To determine the nature of vocational rehabilitation clients' occupational entry into the competitive labor force after vocational rehabilitation closure, by generating a relative profile for the vocational rehabilitation client population within the total labor force which shows characteristic patterns of their entry jobs in terms of fields, skill levels, and wage levels.
2. To identify the work adjustment or adaptation problems uniquely encountered by disabled workers after placement.
3. To examine disabled workers' work adjustment in terms of satisfaction/dissatisfaction and satisfactoriness/unsatisfactoriness relative to their occupational functioning.
4. To determine the extent to which disabled workers' work motivation might be related to their work satisfaction and performance.
5. To identify variables which might serve to moderate disabled workers' work motivation-satisfaction relationship.
6. To investigate if certain job content and context elements might tend to function as satisfiers or dissatisfiers to disabled workers.
7. To identify factors which might contribute to disabled workers' successful (or satisfactory) work performance.
8. To identify third-variables which might contribute to more satisfactory explanation of disabled workers' work satisfaction-performance relationship.
9. To determine the extent to which disabled workers' work adjustment after rehabilitation closure might be attributable to the absence, as opposed to the presence, of vocational training during the rehabilitation stage.

METHODOLOGY:

1. The project objectives are to be accomplished through three consecutive phases of investigation. Phase 1 involves intensive analysis of a state R-300 data set and the corresponding labor statistics. Phase 2 is a survey stage within which a sample of disabled workers (former VR clients) and their respective employers are contacted. Phase 3 is to be an experimental study within a sheltered workshop.
2. A sample of approximately 4,600 VR clients who were successfully closed (Status 26) and placed in competitive employment (work statuses at closure 1, 3, and 4) during FY 1975-76 in West Virginia is involved in Phase 1. Phase 2 requires a sample of approximately 200 clients who have been successfully rehabilitated (closure status 26), with one half of them having received vocational training (status 18) and the other half not, and their respective employers. A sample of approximately 20 sheltered workers (work status at closure 2) who have been successfully closed by VR (status 26) is to be involved in Phase 3.

3. Phase 1 addresses itself to 5 VR outcome variables (weekly earnings at closure, field of occupation at closure, etc. - the primary variables) and some 34 VR intake and process variables (age, sex, major disability, months from acceptance to closure, months in training, etc. - the secondary variables). Phase 2 taps 24 primary variables (including such employment variables as occupational title, weekly earnings, satisfiers and dissatisfiers of job elements, work satisfaction, and work proficiency and such personal attributes as locus of control, self-esteem, self-acceptance, perception of success, work motivation, and work personality) and 9 secondary variables (sex, age, major disability, highest grade completed, etc.). Primarily two independent variables, self evaluation of work proficiency and pressure for production, and two dependent variables, work satisfaction and work performance, are to be investigated in Phase 3.
4. Univariate, bivariate, and multivariate descriptive and inferential statistics are used for data analyses.

FINDINGS TO DATE: The first phase of the project carried out to date reveals the following characteristics for a state R-300 data set for FY 75-76.

1. Of the clients closed in Status 26, approximately 71% were placed in competitive employment (work statuses at closure, 1, 3, and 4).
2. As compared to those who were successfully closed but not placed in competitive employment (work statuses 2, 5, and 6), clients who were successfully closed and placed in competitive employment (work statuses at closure 1, 3, and 4) were found to have significantly different means on 6 ordinal intake variables and 2 ordinal process variables. They were on the average:
 - a. younger, with a mean age 33.8 as opposed to 41.5 ($p < .001$).
 - b. having more dependents, with a mean number of dependents 1.2 as opposed to 0.6 ($p < .001$).
 - c. from smaller families, with a mean number in family 3.3 as opposed to 3.5 ($p < .05$).
 - d. more educated, with a mean grade level 9.9 as opposed to 8.6 ($p < .05$).
 - e. earnings more at referral, with a mean weekly earning \$35.10 as opposed to \$5.60 ($p < .001$).
 - f. representing higher monthly family income at referral, with a mean 3.0 which is equivalent to \$275 as opposed to 2.8 which is equivalent to \$240 ($p < .01$).
 - g. participants of longer period of training, with a mean months of training 3.3 as opposed to 1.0 ($p < .001$).
 - h. recipients of more services, with a mean total number of services 2.4 as opposed to 2.3 ($p < .001$).
3. The frequency distribution of the competitive closures (work statuses at closure 1, 3, and 4) based on the 9 one-digit occupational categories was, in rank order, as follows: (a) code 3 service occupations (35.5%); (b) code 2 clerical and sales occupations (18.4%); (c) code 9 miscellaneous occupations (10.6%); (d) code 0-1 professional, technical, and managerial occupations (10.5%); (e) code 8 structural work occupations (9.5%); (f) code 6 machine trades occupations (4.5%); (g) code 7 bench work occupations (4.2%); (h) code 5 processing occupations (3.9%); (i) code 4 farming, fishery, forestry and related occupations (2.9%).
4. The distribution of those who entered the service occupations (one-digit code 3) based on the corresponding two-digit occupational codes was, in rank order, as follows: (a) code 31 food and beverage preparation and service (30%); (b) code 38 building and related service (18.0%); (c) code 35 miscellaneous personal service (17.8%); (d) code 30 domestic service (15.4%); (e) code 36 apparel and furnishings service (6.4%); (f) code 33 barbering, cosmetology, and related service (4.8%); (g) code 37 protective service (4.2%); (h) code 32 lodging and related service (2.9%); (i) code 34 amusement and recreation service (0.5%).
5. The occupational distribution of those placed in the clerical and sales occupations (one-digit code 2) based on the corresponding two-digit codes was, in rank order, as follows: (a) code 20 stenography, typing, filing, and related occupations (25.5%); (b) code 29 merchandising, except salesperson (23.0%); (c) code 21 computing and account-recording (17.8%); (d) code 26-28 salespersons, commodities (16.4%); (e) code 23 information and message distribution (7.1%);

- (f) code 22 material and production recording (6.2%); (g) code 24 miscellaneous clerical (2.7%); (h) code 25 salespersons, service (1.3%).
6. The occupational distribution of those placed in the miscellaneous occupations (one-digit code 9) was as follows: (a) code 91 transportation, not elsewhere classified (28.6%); (b) code 90 motor freight (24.0%); (c) code 93 extraction of minerals (18.4%); (d) code 92 packing and materials handling (17.0%); (e) code 95 production and distribution of facilities (6.2%); (f) code 97 graphic art work (1.7%); (g) code 94 logging (1.5%); (h) code 99 vending stand operation (1.5%); (i) code 98 other (0.8%); (j) code 96 amusement, recreation, and motion picture not elsewhere classified (0.4%).
7. The occupational distribution of those in the professional, technical, and managerial occupations (one-digit code 0-1) was as follows: (a) code 09 education (20.5%); (b) code 07 medicine and health (18.2%); (c) code 18 managers and officials, not elsewhere classified (16.7%); (d) code 19 miscellaneous professional, technical, and managerial (12.6%); (e) code 16 administrative specialization; (f) code 00-01 architecture and engineering (6.3%); (g) code 15 entertainment and recreation (4.6%); (h) code 04 life sciences (4.0%); (i) code 12 religion and theology (2.9%); (j) code 02 mathematics and physical sciences (2.1%); (k) code 14 art (2.1%); (l) code 10 museum, library, and archival sciences (1.3%); (m) code 13 writing (1.0%); (n) code 11 law and jurisprudence (0.4%).
8. Application of Bayes' theorem of conditional probabilities relating rehabilitation outcome competitive versus noncompetitive closures (knowing prior probabilities of these closures to be 0.71 and 0.29 respectively with a sample of 6,436 clients), to the client intake characteristic vector elements sex (male 1, female 2), marital status (never married 1, married and other 2), work status at referral (competitive 1, noncompetitive 2), and primary disability (visual 1, auditory 2, orthopedic 3, amputation 4, mental 5, other 6) revealed the following:
- Whenever there is a combination of 111 in the first three elements of the client intake characteristic vector, assignment to the competitive closure is associated with the highest probability (posterior probability) of being correct ($p < 0.99$). This implies that clients who are males, never married, and competitive at referral work status-wise are most likely to be closed by VR in the competitive work group after appropriate rehabilitation services are rendered, regardless of their primary disability.
 - For males (1 in the first element of the vector) whose work status at referral is noncompetitive (2 in the third element), single clients (1 in the second element) are more definitely to be closed in the competitive group as compared to married clients (2 in the second element). The posterior probability of correctly assigning the "112" cases to the competitive closure ranges from 0.91 to 0.95, whereas the posterior probability of correctly classifying the "122" cases to the competitive closure ranges from 0.80 to 0.88.
 - Whenever there is a combination of a 2 in the first element and a 2 in the third element of the client vector, assignment of the case to the noncompetitive closure with the posterior probability ranging from 0.29 to 0.67. This implies that if a client is female and her work status at referral is noncompetitive, it is more likely that her work status at closure is noncompetitive, when successfully closed (with posterior probability greater than 0.29 which is the known prior probability associated with the noncompetitive closure).
 - In connection with the above finding especially with respect to marital status, there is a distinctive difference between those who are never married (the 212 cases) and those who are married (the 222 cases). The "212" cases are associated with lower posterior probability of noncompetitive closure ranging from 0.29 to 0.43, whereas the "222" cases are associated with higher posterior probability noncompetitive closure ranging from 0.53 to 0.67. This means that as compared to single females, married females whose work status at referral is noncompetitive are more likely to be closed by VR in the noncompetitive work group.
9. Application of Bayes' theorem of conditional probabilities relating rehabilitation outcome competitive versus noncompetitive closures (with known prior probabilities associated with these closures to be 0.71 and 0.29, respectively with a sample size of 6,436 clients) to the rehabilitation process vector which consisted of four vector elements restoration service (no 0, yes 1), college

training (no 0, yes 1), maintenance service (no 0, yes 1), and service to family member (no 0, yes 1) revealed the following:

- a. Whenever there is a combination of 111 in the last three elements of the process vector, assignment of the case to the competitive closure is associated with the highest probability (posterior probability) which is greater than 0.99. This indicates that clients who receive a combination of college training, maintenance service, and service to family member would most likely be placed in competitive employment at closure, regardless of whether they receive restoration service (the first element of the process vector) or not.
 - b. The process vector (0000) signifies the absence of all four rehabilitation services considered in the analysis, while the vector (0001) signifies the presence of service to family member but the absence of the three remaining services. The former vector has a posterior probability of 0.77 associated with competitive closure, whereas the latter vector has a posterior probability of 0.87 associated with competitive closure. The net difference between these two vectors is the service to family member showing a corresponding difference in posterior probability of $p=0.87 - 0.77=0.10$ for competitive closure. This implies that service is worth approximately ten percentage points in connection with closing the client in the competitive work status.
10. Skill level associated with occupations at closure for a sample of 4,584 clients, who had been closed placed in competitive employment, were analyzed based on the fourth digit of the occupational codes which represents a worker trait in terms of the relationship of the job to data having these weights 0 synthesizing, 1 coordinating, 2 analyzing, 3 compiling, 4 computing, 5 copying, 6 comparing, 7 and 8 no significant relationship. The occupational skill level analysis revealed the following:
- a. The occupational divisions which require, on the average, the highest levels of skill were life sciences (mean skill level 0.8); law and jurisprudence (mean 1.0); religion and theology (mean 1.4); art (mean 0.8); entertainment and recreation (mean 0.5); administrative specialization (mean 1.2); managers and officers, n.e.c. (mean 1.0); and miscellaneous professional, technical, and managerial (mean 1.4).
 - b. Among the nine major occupational categories, professional, technical, and managerial occupations (with mean skill level 1.7) would require, on the average, the highest level of skills, whereas processing occupations (mean skill level 7.5) require, on the average, the lowest degree of skills in so far as the relationship of job to data was used as a basis for measuring for the skill level. Clerical and sales occupations (mean skill level 3.5) ranked only next to professional, technical, and managerial occupations in terms of the mean skill level required. They were followed in rank order, by machine trades occupations (mean skill level 4.0); structural work occupations (mean skill level 5.6); bench work occupations (mean skill level 6.2); miscellaneous occupations (mean skill level 6.4); farming, fishery, and forestry occupations (mean skill level 6.6); service occupations (skill level 7.3); and processing occupations (mean skill level 7.5).
11. A wage level analysis carried out with a sample of 4,516 closed placed clients revealed the following:
- a. The top ten occupational divisions having, on the average, the highest weekly earnings at closure were, in rank order, fabrication and repair of plastics, synthetics, etc. (mean weekly earnings \$257.40); law and jurisprudence (mean \$217.50); extraction of minerals (mean \$181.16); processing of chemicals, plastics, etc. (\$173.15); architecture and engineering (mean \$161.53); electrical assembling, installing, and repairing (mean \$159.04); processing of petroleum, coal, etc. (mean \$157.00); life sciences (mean \$156.42); excavating, grading, etc. (mean \$150.25); mathematics and physical sciences (mean \$149.30).
 - b. Professional, technical, and managerial workers who constituted 10.5% of the competitively closed cases ranked at the top with a mean weekly earning at closure of \$123.42. Service workers who represented the largest group of competitively closed cases at 35.5% in the sample, made the next to the lowest mean weekly earning of \$74.19 (ranking 8). Farming, fishery, and forestry workers who belonged to the smallest group of 2.9% in the sample ranked at the bottom of hierarchy (rank 9) with a mean weekly earning of \$66.02. The other six major occupational categories occupying ranks 2 through 7 were, in order,

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structural work occupations (mean weekly earning \$122.60), miscellaneous occupations (mean \$117.58), processing occupations (mean \$113.17), machine trades occupations (mean \$109.57), bench work occupations (mean \$99.06), and clerical and sales occupations (mean \$88.04).

- c. Comparisons of retention cases (cases whose work statuses at referral being 1, 3, or 4) and nonretention cases (cases unemployed at the time of referral or those whose work statuses at referral being 2, 5, or 6) on weekly earning at closure using the t-test for independent samples revealed that only 7 out of 72 occupational divisions represented by occupations at closure did differentiate the two groups significantly beyond the .05 level. In other words, there were no significant mean differences on weekly earnings at closure between the retention and nonretention groups for 65 out of 72 occupational divisions investigated. This means that within our client population we could expect the retention and nonretention cases to be homogeneous in terms of their weekly earnings at closure for a large number of occupations. This inference is, in fact, contrary to the speculation that work experience would have an overwhelming influence on wage levels. Moreover, among the 7 occupational divisions in which the mean weekly earnings of the two groups showed significant differences ($p < .05$), the majority of them (4 to be exact) were in the professional, technical, and managerial category and almost all of them (except one, logging) had negative t values reflecting significantly larger mean weekly earnings for the nonretention group over the retention group. This is, indeed, a somewhat surprising finding.
- d. To show a relative profile of our client population within the general labor force especially with respect to their weekly earnings at closure, a selected number of occupations (in terms of production workers by industry) were examined in regard to their respective national, state (West Virginia), and VR client weekly earning wages. The industries involved were stone, clay, and glass; primary metals; fabricated metals; machinery; electrical machinery; transportation equipment; food and kindred products; apparel; printing and publishing; chemicals, rubber and miscellaneous plastics; bituminous coal mining; and electric, gas, and water. Generally speaking, for all but two of these industries, the state and national averages were found to be roughly from 1 to 2 standard deviations above the average weekly earnings of our clients. In these two industries, apparel and chemicals, rubber, and miscellaneous plastics, the average weekly earnings (at closure) of our clients were found to be approximately the same as the state and national averages of their respective fields.

APPLICABILITY: This project produces much needed data on the circumstances of those former VR clients in the world of work. It is hoped that the data can be utilized in such areas as (1) sensitizing the rehabilitation personnel to the relative VR contribution to the nation's labor force, (2) post-closure follow through services, especially in reference to the competitive employment, (3) job development and job placement, (4) program evaluation using client post-closure job functioning as a criterion, and (5) other applications relative to the rehabilitation services involving jobs.

201 Job Obtaining Behavior Strategy (JOBS): The Use of Group Counseling and Intensive Behavioral Instruction for Vocational Placement of Rehabilitation Clients

Principal Investigator:	Michael D. Wesolowski, Ph.D.	
Status:	Continuing	
Dates:	March 1978-March 1981	
Cost:	Annual \$54,742 RT Annual \$37,258	Projected Total \$114,000 RT % of Annual Total 68%
Annual Report Reference:	#13, Page 292, R-41	

OBJECTIVES:

1. The purpose of this study is to develop JOBS groups in selected rehabilitation centers and field offices that will cooperate with HEW with regard to this project.

2. To collect data to ascertain the proportion of VR clients who obtain employment through the JOBS groups, and these data are to be compared to the proportion of VR clients who obtain employment via existing methods of procuring jobs.
3. To collect data regarding the differences in wages, job satisfaction, and job retention between JOBS groups and other groups. Also, data will be collected regarding a client's expanding social support network as a result of the JOBS program.
4. After initial rehabilitation of the JOBS project, an attempt will be made to train rehabilitation workers and clients of other rehabilitation centers and rehabilitation field operations in the JOBS program.

METHODOLOGY: A group of 8 to 12 job-ready (status 20) clients meet with a placement specialist for 4 hours a day, 5 days a week. During this time, the clients contact friends, relatives, and former employers by telephone, look through help-wanted ads in the yellow pages of the phone book and exchange job information within the group. Clients are expected to find 10 job leads a day and arrange for 2 employment interviews a day. The interviews are arranged for a time outside the group session. Also, in the group sessions, clients compose resumes, obtain letters of recommendation, role-play interviews, discuss employment objectives, and provide each other with moral support.

FINDINGS TO DATE: The JOBS project has been established in Washington, D.C., and Morgantown, WV. The Washington, D.C. office has been operating since November, 1978, and the JOBS group has about a 67% rate of placement. No data are yet available regarding the rate of placement specialists who are not using the JOBS method in Washington, D.C. Also, no data are available regarding the Morgantown, WV project since it is just beginning. The most significant finding to date is that there is a high positive correlation (.9) between attendance in the JOBS groups and getting a job.

APPLICABILITY: Although there has been much discussion about the placement process in rehabilitation, the placement process in the rehabilitation service delivery system has been professionally the least implemented area among the various services available from team members for the severely disabled individual. Given impetus from the Vocational Rehabilitation Act of 1973 and especially Section 503 on Affirmative Action, there has been renewed interest and emphasis on the placement process. Within the placement process, the teaching of job seeking skills to clients is important and often neglected. The focus of this project is to teach rehabilitation clients to assume an active role in job seeking as well as studying variables related to client placement. Further, the study will show the best method of establishing such a program in a state agency.

202 Field-Based Microcomputer-Assisted Vocational Rehabilitation Counseling System

Principal Investigator:	M.S. Tseng, Ed.D.	
Status:	New	
Dates:	May 1978-April 1981	
Cost:	Annual \$54,942 RT Annual \$40,625	Projected Total \$123,000 RT % of Annual Total 74%
Annual Report Reference:	#13, Page 204, R-37	

OBJECTIVES:

1. To design a prototype of a microcomputer-assisted vocational rehabilitation counseling system which would consist of adequate microcomputer hardware and software and vocational rehabilitation information software.
2. To test the prototype system for its efficiency, reliability, capabilities and limitations.
3. To demonstrate the operation of the prototype system to the preservice rehabilitation counselors and, on the basis of their feedback, to carry out modifications if necessary to maximize the operability and utility of the system.

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4. To implement the prototype system in the field for the inservice rehabilitation counseling professionals, including managers as well as counselors.
5. To evaluate the impact of the prototype system in the field.

METHODOLOGY:

1. A preassembled general-purpose microcomputer hardware together with the supporting software is to be selected from among the systems which are available on the market.
2. Vocational rehabilitation information software packages compatible to the microcomputer system acquired are to be designed in such a way as to enable a rehabilitation counseling personnel in the field to (a) input the client data to the system and have the client profiles relative to certain predetermined and known norms plotted and returned to him/her, (b) input the client intake and/or process data to the system and have estimates or projections of certain process and/or outcome measures calculated and returned to him/her, and (c) request the system to store, update, and process caseload statistics reports produced and returned to him/her.
3. In order to determine such a system characteristics as speed, reliability, compatibility, and flexibility, system analyses are to be conducted.
4. The system is to be evaluated and modified, if necessary, on the basis of the feedback of approximately 10 preservice rehabilitation counselors who would be interfaced with the prototype using such evaluation criteria as the ease of use, utility to the counselor, effort expenditure, etc.
5. The implementation of the prototype system in the field is to involve a group of approximately 10 inservice rehabilitation counseling professionals.

FINDINGS TO DATE:

1. A microcomputer system has been procured (OSI C3-OEM microcomputer system with 56 K bytes of RAM, ROM, triple CPU, dual double-sided 8-inch diskette drive providing 1 megabyte storage on-line, serial and parallel I/O, ACT-V 12-inch CRT display, OS-CP/M Disk Operating System, FORTRAN-IV compiler).
2. In conjunction with the caseload management component of the system an effort has been made to develop an effective and uniform means of computer-assisted data entry, retrieval, and analysis by examining and comparing varying recording elements and times of recording associated with Forms R-300, West Virginia DVR-100, and Maryland R-13.

APPLICABILITY: When successfully completed this project will introduce a prototype of the microcomputer-assisted vocational rehabilitation counseling system to the field of rehabilitation counseling.

A field professional will have:

1. an extrinsic means with which client data can be quickly stored, retrieved, and analyzed,
2. a high-speed clerical tool with which client records can be maintained and updated,
3. a reporting system through which weekly and/or monthly caseload statistics reports can be generated with minimum effort, and
4. an instant access to large quantities of information.

203 Developing a Model for State-Wide Study on Ineligible Cases (08)

Principal Investigator:	Ranjit K. Majumder, Ph.D.	
Status:	New	
Dates:	May 1978-April 1980	
Cost:	Annual \$40,567	Projected Total \$56,000
	RT Annual \$27,579	RT % of Annual Total 68%
Annual Report Reference:	#13, Page 213, R-38	

OBJECTIVES: The primary purpose of this study is to develop an analytical model for studying ineligibility that would be effective in assisting states to reduce or better understand the nature of these closures.

Since this study involved data analysis to determine significance among variables, no hypotheses have been formulated. Rather, in broad data analysis, it appears more appropriate to discuss the types of analysis to be conducted in terms of objectives. The specific objectives are:

1. Determine any relationship between referral source and the number of cases closed from (a) applicant-referral statuses, and (b) extended evaluation.
2. Examine the distribution of 08 closures from (a) applicant status (00), (b) referral status (02) and extended evaluation (06) by reason for closure.
3. Analyze the relationship between reasons for closure and other key characteristics or factors, including: (a) referral source, (b) disability—for both severely and nonseverely handicapped, (c) age, (d) sex, (e) education, (f) SSI/SSDI status, (g) race.
4. Examine case service funds and time spent in statuses to ineligibility based on status (00, 02, 06) for specific disabilities.
5. Examine the extent to which there is a generalized attitude of rehabilitation workers toward 08 closures, particularly those who are classed as uncooperative, unmotivated, and refuse services.
6. Determine the congruence between reason for closure as identified by the VR counselor and by the study.
7. Study reason for closure by client perception of program to determine any factors within the program that may be a programmatic barrier.
8. Develop a protocol or checklist that will assist rehabilitation workers in their periodic review of ineligibility for individual clients and in conducting state-wide studies of ineligibility for all clients.

In line with the need to examine the characteristics of severely and nonseverely handicapped, these two groups will be studied separately and differences or relationships determined. If examination of these data do not show promising results in terms of information about ineligibility, the study would include a small sample of case records within the chosen state in order to attempt to further clarify ineligibility.

METHODOLOGY:

1. **Population and Sample:** The population will be composed of all 08 closures from one state in Region III. This population will be used for the macro analysis. A 10% random sample will be selected for micro analysis as outlined in Procedure.
2. **Procedure:**
 - a. Using R-300 data, the flow patterns of clients within the 08 closure category will be analyzed based on the distribution of closures from statuses 00, 02, and 06, by closure reason. Reason for closure will then be analyzed, based on age, sex, SSI/SSDI status, marital status, and work status. Further, an attempt will be made to determine if there are any distinguishable features between 08 closures and the clients who reach status 12.
 - b. Based on the findings from "reason for closure" (reasons being, unable to locate; handicap too severe; unfavorable medical prognosis; refused services; failure to cooperate; no disabling condition; no vocational handicap; and other) as determined from R-300 data, additional analyses will be performed, involving both client and counselor. Four classificatory dimensions—demographic, status, attitudinal, and organizational variables—will be considered in the questionnaire development plan.

No attempt will be made to investigate clients closed as "deceased," "transferred to another agency," or "institutionalized," unless one of these closure categories represents more than 5% of the closures from either status 00, 02, or 06. In case of a larger than 5% closure rate, a sample will be drawn and contacts made to determine appropriateness of closure reason.

3. **Analyses:**
 - a. A one-way ANOVA will be used to study the differential amount of time and case service

funds expended on various disability groups. This procedure will also be used to detect any differential closure patterns due to age, sex, education.

- b. A 10x3 chi square analysis will be conducted to determine differences in reason for non-acceptance and closure from the separate statuses of 00, 02, and 06. Additional chi square analyses will be conducted using status, sex, SSDI, and SSI, and education to determine difference.
- c. The questionnaires will be compiled and analyzed for both client and counselor as appropriate.

Appropriate interviewers will be selected from among counselors or counselor trainees. Interviewers will be provided with an orientation of the instruments, and will be monitored for reliability.

FINDINGS TO DATE: As planned, two types of activities were carried out during last year.

1. Using a 10% sample, a preliminary analysis was made about the 08 closures; and
2. preparation was made to develop instruments for the study client and counselor.
Our preliminary observations can be summarized as follows:
 1. A large segment of the total referrals end by being ineligible cases (as high as 50% or more) and if possible, the acceptance rate should be improved.
 2. Other things being equal, the determination of ineligibility should be done as early as possible in the 00, 02, 06 status process.
 3. Among the disability categories mental retardation, mental condition and orthopedic cases are declared ineligible at a relatively high rate (78% - 85% ineligibility rate). It is rather too early to pinpoint the problem and suggest any remedy. But it appears such a high rate of rejection calls for intense analysis, particularly if the severely handicapped cases are thrown out of the program.
 4. Much concern is being expressed about the differential and conflicting incentives in participating between VR and other federal health, education and maintenance programs. In other words, there are no unequivocal advantages of VR programs over some of these other federal programs such as SSI, SSDI, etc. and probably high rejection rate (80%) of SSDI applicants is quite natural against the relatively low rejection rate (37%) of non-SSDI applicant clients. To reduce the rejection rate among the SSDI applicants may require substantial adjustment of benefit structure between the VR program and SSDI program.
 5. It is interesting to note that fewer females were found ineligible than males, and more detail will be needed to explain why.
 6. Work history at the time of referral appears to have a bearing on eligibility decision that is those who were in competitive labor market are accepted at a higher rate in the VR program. Knowing VR program's commitment to vocational achievement, such higher acceptance is expected. However, it may be true that those clients who did not have any work history, may need VR services more in order to be able to enter the world of work.
 7. Examination of the reasons for being ineligible shows that more than 50% of the cases were closed because they either refused to receive services or failed to cooperate with VR agencies. Study of these categories alone can shed important light as to how to remove some of the program barriers in order to reduce the rejection rate.

On the basis of some discussion with several rehabilitation professionals, we have developed three tentative instruments: (1) Counselor Survey Schedule; (2) Client Survey Schedule; and (3) Case Documentation Review. The next step will be to try out these instruments for better item selection and developing measurement procedure. When the instrumentation phase is over, these will be administered on a sample of clients and counselors.

APPLICABILITY: The actual findings should be useful to states and to the federal government as they continue their review and interest in clients closed and not accepted for service. Also, the protocol developed should be useful to states in conducting their own studies on an on-going basis. Evaluators will be able to implement the protocol without having to construct their own study, thus resulting in time-saving for states' evaluation units.

204 National Study of Trends in Characteristics of Closed VR Cases as a Function of National Priority on the Severely Disabled

Principal Investigator: Ranjit K. Majumder, Ph.D.
Status: New
Dates: May 1978-April 1981
Cost: Annual \$51,340 Projected Total \$110,000
RT Annual \$35,604 RT % of Annual Total 69%
Annual Report Reference: #13, Page 234, R-39

OBJECTIVES: This study deviates from the traditional hypothesis testing model since it is concerned with analyzing currently available data, based on exploratory objectives. The study has two broad objectives:

1. Determine trends and patterns in program change as a result of the priority to serve the severely handicapped;
2. Compare the current method of developing performance levels (using state means) to a random sampling procedure (using all cases). This comparison will be made for selected standards that make use of RSA-300 data.

The first objective state above has sub-objectives aimed at differentiating between client characteristics of severely and nonseverely handicapped, by severity of disability, on the following:

- | | |
|---|---|
| a. Referral patterns | i. Trends in closures |
| b. Use of extended evaluation | j. Trends in competitive and noncompetitive employment closure |
| c. Patterns of ineligibility | k. Changes in ratio of rehab in terms of case service costs, client-counselor ratio, facility-served client ratio, and program priorities since 1974 Act. |
| d. Case service expenditures | |
| e. Trends in time to rehabilitation | |
| f. Patterns of services rendered to clients | |
| g. Demographic characteristics of clients | |
| h. Referral and Closure income | |

Also in this study profiles will be developed using Profile Analysis Technique (PAT) that depict trends in programmatically useful charts.

The sub-objectives under objective 2 should permit answering a series of programmatic questions regarding trends such as:

- a. **Intake:** Following the 1973 VR Act, are proportionately more severely handicapped than non-severely handicapped: (a) referred to VR? (b) accepted by VR?
- b. **Intervention:** Following the 1973 VR Act, do the severely handicapped, compared to nonseverely handicapped: (a) spend more time in the VR system? (b) receive more training services? (c) receive more physical and mental restoration service? (d) receive more maintenance services? Is more money being spent on the severely disabled than nonseverely disabled?
- c. **Output:** Following the 1973 VR Act, do the severely handicapped show an increase in competitive placements than the nonseverely handicapped?

The answer to these questions can then be compared to such priorities as shown in state plans and PFPs.

METHODOLOGY:

1. **Population and Sample:** National data for the fiscal years of 1971 through 1976 will constitute the population. Principal source of data will be that contained on the RSA-300 form. A 5% stratified random sample (based upon the states) will be drawn for each of the six years from the client data set. The sample size for each year is being estimated at 50,000.

The study plans to investigate the program change and associated trends and characteristics occurring primarily at the national level, and in some areas, at the state level. In addition to the RSA-300 data source, other sources of information (for example, Annual State VR Reports; Statisti-

cal Reports and Financial Plans published by the RSA, etc.) will be utilized insofar as data on rehab manpower, funding level, rehab facility and program priorities, etc. are concerned.

2. **Procedures:** Drawing sample from each of the six years data and analyzing data using the following variables: severely versus nonseverely handicapped for designatable categories; primary disability; age; education; referral source; extended evaluation use; ineligible (08 closures); successful rehabilitation (26); unsuccessful closure (28 and 30); closure income and referral income; placement (i) in competitive employment, (ii) in sheltered workshops, (iii) as self-employed, (iv) in BEP, (v) as unpaid family worker, and (vi) as student; case service costs; time to closure; facility cost; and SSDI cost.

As the data are being analyzed for each year, as stated above, the data will also be analyzed for appropriate standards to determine performance level based on sampling national data instead of the current mean of the state means approach.

A series of ANOVAs will be conducted using the appropriate independent variables for each continuous dependent variable. Chi Square analysis will be used when the measures are nominal in nature. Also, insofar as it is possible, the data will be analyzed in light of the changes over time as a result of the emphasis on the severely handicapped. Since that emphasis started in 1973, prior years' data provide an excellent comparative basis for severely disabled categories that are without qualifications.

Stepwise regression and time series analysis will be conducted using such variables as cost of services, time in rehabilitation, income at referral or closure, level of education, age, etc. A data validity check will be conducted by comparing case records to R-300 data using a 1% subsample from the original sample drawn.

FINDINGS TO DATE: Since the funding of the project last year, major efforts have been directed toward collection of national data on rehab clients, rehab program information such as, cost (by rehab services, administration, counseling and placement, small business enterprises, rehabilitation facility, workshop, construction), manpower, universe of eligible disabled persons, program indicators) persons to be served, rehabilitated and not rehabilitated), priority service target groups (e.g., severely handicapped, alcoholics, public offenders, etc.) labor market condition, industrial and business activity and population characteristics for the period 1971-1976. Also, national R-300 data on all handicapped clients served by the state-federal VR program for the fiscal years 1971 through 1976 have been collected and new sets of edited data, based on 5% sample, are being generated. Because of the large volume of data and relatively long computer turn around time, data editing and preparation is moving rather slowly. Since the total number of observations for each fiscal year ranges from 1 to 1.9 million, the sample size will vary from 50K to 95K observations. The data set will include 62 different variables—30 intake, 24 process, and 8 outcome variables. Using a major classification scheme based on severity of handicapping condition, the data elements will be summarized and profiled over the six-year span.

Wherever possible all of the general economic data will be merged with the rehab client-program data to determine the intrinsic and extrinsic relationship among the various input, process and outcome measures with particular emphasis on the rehabilitation success or failure of the severely handicapped.

APPLICABILITY: Knowledge about how the program changes occur over time could provide managers and administrators at the state and federal level with insights that would affect planning and evaluation efforts. Also, state evaluation personnel could use these data for comparison of their state's efforts in conjunction with continuing statewide studies that go beyond the standards in their depth. Findings from the study will assist the leaders of rehabilitation: (a) in understanding what is involved by way of time, money and manpower to implement a priority program; and (b) to take appropriate measures (if needed) to correct the direction of the program in order to attain the goal. If the current method of calculating performance standards is verified, no change in this area would be necessary.

However, if the comparison reveals differences in levels based on computation method, then this would call for a policy decision on the part of RSA, as to how those performance levels should be calculated.

Additionally, data about the nature of change over time in the rehabilitation program should provide administrators with more accurate data for planning and projection purposes. This could promote data-based decision-making by: Administrators (CSAVR), RSA Central Office, and legislative sub-committees.

205 Role and Impact of Consumer, Provider/Advocacy and Advocacy Groups on Vocational Rehabilitation Policy - The National Experience

Principal Investigator:	Antonio Jones, M.A.	
Status:	New	
Dates:	May 1978-April 1980	
Cost:	Annual \$46,864 RT Annual \$21,699	Projected Total \$45,872 RT % of Annual Total 46%
Annual Report Reference:	#13, Page 261, R-40	

OBJECTIVES: The purpose of this research is to analyze the Federal Vocational Rehabilitation policy in relation to consumer, provider/advocacy and advocacy group input into the policy development. The following objectives are central to this research.

1. To determine how VR has evolved in the statutes from 1920 to present.
2. To determine what policy positions have been advanced by each of the three types of groups.
3. To determine the relationship between the group input and policy output.
4. To determine the nature in size and membership of the various groups.

METHODOLOGY: The initial rehabilitation act and all subsequent amendments will be analyzed in terms of the six focal points of the study (change in clientele groups, eligibility, allowable services, allowable employment objectives, funding, civil rights and other major changes). To organize the statutory data, we will use the "Statutory Analysis Data Retrieval Form." In addition, a "Supplemental Data Retrieval Form" for statutory analysis will be used for statutes found in the VR acts that are not administered by Rehabilitation Services Administration. An example is Section 503 of the Rehabilitation Act of 1973, in which the Department of Labor serves as implementing agency.

To organize group positions, we will use a "Group Input Data Retrieval Form." This form will allow coding for type of input, policy position, and group opposition or support.

To determine the role and impact of consumer, provider/advocacy and advocacy groups upon policy formation in Vocational Rehabilitation, we propose to use the group approach, i.e., analyze the VR statutes in relation to group impact upon their development.

Policy Boundary: Earlier we discussed several definitions of public policy. We believe the following units of policy meet the Kerr definition.

Unit of Policy Analysis: U.S. Statutes mandating the Vocational Rehabilitation program. At the present time, the citation is 29 USCA 701, et seq. The approach will be incremental, i.e., the research will treat each act and amendment as a separate unit of analysis, comparing the input (by the groups) with the output (statutes), using the correlation analysis indicated in the Analysis of Data Section. In addition to the individual (i.e., incremental) consideration of the data, a time series longitudinal analysis of the input and output will be employed to map the direction of policy change over time.

Group Input Boundary: The group input of this study will be taken from the hearings of the Senate and House Subcommittees charged with handling the VR Act during any specified year.

Unit of Group Input Analysis: Subcommittee Hearings will be analyzed with regard to the policy positions taken by representatives of the various groups. The policy positions may be in the form of oral (recorded) or written testimony, responses to questions by the Congressmen, and departmental reports and communication.

Analysis of Data: The analysis of the positions taken by the groups at this stage of policy forma-

tion will be analyzed in relation to (1) success, (2) partial success, (3) coalitions, (4) oppositions, (5) common positions, (6) periods of increase in number of certain types of groups, and (7) changing positions by the same group. Such analysis will be aimed at uncovering trends in the statutory evolution of VR policy. We anticipate policy positions advanced by groups of all three types (consumer, provider/advocacy, and advocacy) to be advanced on several occasions prior to success. The impact of specific groups may be indicated by the degree to which coalition formations including those groups prove to be successful. Positions advanced by specific groups (whether in opposition or in support) should prove to be partially successful until dominant group-types coalesce on the issue. We expect, in turn, that the dominance of one group-type over the others would be a function of the statutory content of VR policy at the latest stage of development.

*The authors recognize that there will be various changes made in the law that do not merit a specific category, but are significant in terms of group impact on policy.

FINDINGS TO DATE: Preliminary findings last year indicate:

1. **Multiple policy positions** are espoused by the various groups making input. Many of these positions are very specific to the goals of the particular organization, e.g., a professional association wanted policy provisions to assume that VR agencies perform certain diagnostic tasks that were central to their professions. Other groups gave general support to the continuance of VR as a program.
2. Representation of each type of group was about split between consumer and provider/advocacy with only a very small number of advocacy groups (the authors realize possible confusion of the terminology of group types) they are considering alternatives to alleviate this problem.
3. Striking **success** by all types of groups is indicated. Also, there appears to be very little conflict between group types.
4. A summary of the 1978 Amendments to the Rehabilitation Act is contained in a publication called "Section Analysis of the Rehabilitation Comprehensive Services, and Developmental Disabilities Amendments of 1978," Research and Training: Institute, WV (1979).

APPLICABILITY: Relevance of the Problem to Rehabilitation: This research is relevant to Rehabilitation from two perspectives. First, the research focuses upon VR policy determination including consumer and advocacy group input. Second, the statutory analysis will provide longitudinal data that will be useful in future policy and program evaluation research.

This study will attempt to measure a very important part of consumer input into the policy making process. Even though it is at the macro level, it will hopefully provide insights into the past and current role of consumer and advocacy groups in the policy making process.

The research project findings will be utilized by policy analysts, program evaluators, general management staff. Also, the findings will serve as the basis for further VR research at both intra-policy and inter-policy levels.



**University of Oregon (RT-16)
Mental Retardation Rehabilitation Research and Training Center**

CORE AREAS

Program Related Assessment

The development of client assessment strategies and specific instruments that measure the behaviors of mentally retarded adults that are critical determinants of their potential for community adjustment.

Professional Growth and Development

Activities aimed at improving understanding of the major roles and functional demands of supervisory and management personnel in rehabilitation agencies; e.g., staff development specialists, rehabilitation educators, and first-line supervisors of rehabilitation counselors.

UNIVERSITY OF OREGON

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COMPLETED

ABSTRACT NO.

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PROPOSED

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206 Rehabilitation Short-Term Training: A Follow-Up Study (Training Evaluation Kit)

Principal Investigators:	Philip Browning, Ph.D. Mike Shinnick, Ph.D. Barbara Ayers, Ph.D.
Status:	Completed
Dates:	March 1975-December 1979
Cost:	Annual \$17,477 RT Annual \$17,477
Annual Report References:	Projected Total \$165,000 RT % of Annual Total 100% #13, Page 129, R-35 #14, Page 144, R-35

OBJECTIVES: The purpose of this study was to investigate the validity of a follow-up instrument designed to measure the effects of training. Specifically, the two major research questions were:

1. Do training participants' change responses to the TEK follow-up instrument correspond with the documentation of those responses via personal interview?
2. Do training participants' change responses to the TEK follow-up instrument (as well as the same instrument administered via personal interview) correspond with their supervisors' ratings of trainee change?

METHODOLOGY: The instrument examined in this study is a component of the **Training Evaluation Kit (TEK)** developed at the University of Oregon. The Follow-up Evaluation Booklet (FEB) is primarily a YES/NO self-report form with question items subsumed under the headings of Professional Development and Professional Practice. These items pertain to job-related behavior changes attributable to training.

The subjects for this study consisted, in part, of 63 trainees of four short-term in-service training programs designed for rehabilitation practitioners. Additional subjects were 22 supervisors who were directly responsible for these persons.

Three steps were implemented for data collection. First, the participants who attended the four workshops received FEB via mail three to six months after training. The purpose was for them to indicate job-related behavior changes which they attributed to their training experience. Second, the participants who completed and returned FEB were interviewed via telephone. The purpose was to verbally administer the same instrument in order to address agreement of response over time **and** to elicit documentation of all YES responses to determine if there was substantial evidence to warrant their change response(s). Finally, the supervisors of the in-service training participants received a comparable FEB instrument via mail. The purpose was to elicit their independent judgment of trainee change (i.e., their supervisees) with respect to the same YES/NO job-related change items.

FINDINGS TO DATE: Correlations between trainee responses to the FEB via mail and the FEB via phone interview were significant at $p \leq .001$ for Professional Development items, Professional Practice items, and Total Test items. Percent of agreement analyses yielded values of 84, 71, and 78, respectively for these three sets of items. In addition, trainees were able to substantially document YES responses during the interview with concrete examples of behavior change(s).

Correlations between trainee responses to FEB via **mail** and supervisors' judgment of change in their supervisees were significant at $p \leq .01$ for Professional Development items, non-significant for Professional Practice items, and significant at $p \leq .05$ for Total Test items. Percent of agreement analyses yielded values of 76, 63, and 70, respectively for these three sets of items. Finally, correlations between trainees' responses to FEB via **phone interview** and the supervisors' judgment of change in their supervisees were significant at $p \leq .01$ for Professional Development items, Professional Practice items, and Total Test items. Percent of agreement analyses yielded values of 81, 68, and 74, respectively for these three sets of items.

APPLICABILITY: For the past seven years, the training staff of the University of Oregon Rehabilitation Research and Training Center have been involved in the evaluation of short-term training. The result of this effort is the development of Training Evaluation Kit (TEK). TEK is designed to obtain information on both training process and impact. The process areas of concern are training objectives, methods, and immediate outcome. This evaluative information is used for decision-making directed toward program improvement. The areas delineated for training impact are professional development, professional practice, and information dissemination and utilization. This evaluative information is used to determine accountable change due to training.

This study was intended to further examine the psychometric properties of the TEK Follow-Up instrument which is designed to measure the long-range effects of short-term training. The results lend further support for its usage.

207 A Sociological Look at the Impact of Normalization

Principal Investigators:	Philip Browning, Ph.D. Cindy Rhoades, Ph.D.
Status:	Completed
Dates:	March 1976-August 1978
Cost:	Annual \$6,786 RT Annual \$2,894
	Projected Total \$25,000 RT % of Annual Total 43%
Annual Report Reference:	#13, Page 234, R-42

OBJECTIVES: The primary objective of the study was to ascertain the impact of normalization on retarded persons placed in a group home. Specifically, the objectives were: (1) To investigate the patterns of daily interaction between consumers (retarded adults) and their significant others (service providers and the general public) employing the method of participant-observation; (2) to analyze the field note and interview data derived from participant-observation at three sociological levels, i.e., interpersonal, institutional, and social interaction; (3) to generate propositions and hypotheses relating to normalization within a sociological context.

METHODOLOGY: Since the purpose of this research was to elucidate the meaning and impact of the normalization process for consumers, service providers, and the general public, participant-observation was a particularly appropriate methodology. The study was carried out at two levels—descriptive and analytic. At the descriptive level, participant-observation provided techniques to develop a typology or theoretical model that furnishes an explanation of the factors underlying the observed process of normalization.

The research design was based on the idea that the most valuable information can be obtained from a relatively small group of persons who are significantly involved in the normalization process. Sampling procedures for research informants were adapted to this principle. Instead of discovering typical effects of normalization through extensive sampling they were discovered by intensive study of the interrelationship of three levels of analysis, i.e., interpersonal, institutional, social interaction; (1) The interpersonal level - this aimed directly at efforts to deal with interpreting, adopting, and incorporating normalization and its interpersonal effects; (2) the institutional level - focus was on the institutions involved in the normalization process, i.e., the group home and work setting, in their attempts to prepare the retarded adult for community living. The researcher investigated the contradictions and cross pressures which exist between these institutions and within each one; and (3) patterns and forms of social interaction - the normative rules of giving, receiving, and experiencing normalization "in action" were examined.

FINDINGS TO DATE: Field research has discovered that at the level of implementation, the major corollaries of the North American interpretation of normalization frequently become obfuscated and contradictory. An abstract treatment of the field data collected on this observation has shed light on an unforeseen agenda in the implementation of normalization. Specifically, the overall process of normalization has been discovered to be a practice whereby a category of people are transformed from an undesirably "visible" to an "invisible" social status. This finding has provided the foundation for a whole new way of conceptualizing the experience faced by mildly retarded adults learning to live independently in their community.

Results of the study propose the "theoretical perspective of invisibility" which identifies the overall process of normalization as a complex strategy which is adopted to handle what has professionally been defined as a key societal problem, i.e., deinstitutionalization and integration of mentally retarded people into society. Within the context of the perspective of invisibility, a number of key conflicts of normalization are described and analyzed in the tradition of qualitative research. Illustrative quotes and anecdotes from the field notes breathe life into the theoretical perspective. Six contradictory consequences of the normalization strategy are identified to discriminate various modes and processes of interaction in the normalization process as they involve retarded residents of the group home, staff at the group home and work settings, and the general public. The consequences include: (1) varying levels of commitments to normalization; (2) stress and strain between training forces; (3) problems in identity transformation; (4) impression management and phenomenon of propping; (5) over-normalization and super-standards of conformity; and (6) the sympathetic agent and contingency norms.

Each contradictory consequence is built on the theme of varying levels of understanding and commitment to normalization and organized around the visibility/invisibility perspective. On one level, these discussions can be read as realistic descriptions of experience faced by retarded persons and others in the course of implementing the normalization process. But they can also be read as aspects of an integrated theoretical perspective about contradictory situations which occur in relation to the attempt to extinguish undesireably visible behavior of retarded people so that they may "blend" into society with the rest of us.

APPLICABILITY: A Current movement in field of mental retardation is deinstitutionalization, one result of which has been the development of community alternatives such as group homes.

- The evaluation of community alternatives to date has paid no attention to the details and nuances of the normalization process and their effects on consumers (retarded persons) and their significance to others. In order to demonstrate the success of group home efforts, the direct experience of retarded persons and their adaptation to this transition and change in life-style there must be investigated.

Such knowledge has the possibility of enhancing our learning about important ways to improve the environment of retarded persons so that they may participate more fully in society, contribute as citizens, and, to the extent individually possible, become productive in the economy. In addition, this consumer information has definite implications for pinpointing previously unforeseen problems as they pertain to housing and social barriers. This increased understanding of their experience in "being normalized" has the potential of facilitating and increasing our communication with and understanding of retarded people.

208 Evaluation of Retarded Student Achievement in Career Education Programs

Principal Investigator:	Larry Irvin, Ph.D.	
Status:	Completed	
Dates:	September 1976-August 1978	
Cost:	Annual \$90,606 RT Annual \$4,839	Projected Total \$175,000 RT % of Annual Total 5%
Annual Report Reference:	#13, Page 41, R-43	

OBJECTIVES: The primary purpose of this project is to examine the reliability and validity of testing approaches (using true/false and multiple choice item formats) and a rating approach for testing important student behaviors within career education programs for the mentally retarded. Six specific objectives have been identified.

Predictor Instrumentation

1. Development of preliminary three-option multiple-choice formats
2. Refinement of revised multiple-choice forms and development of two-choice forms
3. Comparison of reliability of alternate formats (true/false, and two-option and three-option multiple-choice)
4. Development of behavior rating instrument

Criterion Validity

5. Development of applied performance criterion instrument
6. Comparison of the validity of alternate forms of item formats within knowledge tests, and of alternate methods of measurement (knowledge testing and behavior rating)

METHODOLOGY:

1. Development of Preliminary Multiple-Choice Formats. Multiple-choice versions of three of the original nine SPIB tests were constructed, using the existing Social and Prevocational Information Battery (SPIB) items as guidelines for content. Prior to piloting with students, all items underwent expert review and appropriate revisions were made. Through counter-balanced presentation of 3 of the possible 4 options to each student, 3-choice versions were field tested.
- 2a. Refinement of Preliminary Forms. Three hundred thirty students from high school EMR classrooms in Oregon, Washington, California, and Texas were tested on the preliminary 48- to 54-item version of each multiple-choice test. Demographic information was also collected. Item difficulty levels, option frequencies, and item/test correlations were calculated for each item. Total test statistics, including average inter-item correlations and Coefficient Alpha internal consistency reliabilities were calculated. Tests were also inspected regarding the representation of content and sub-

FINDINGS TO DATE: Several correlational analyses were used to examine the relative validity of testing and rating approaches for measuring a common criterion. Fairly simple analyses, however, are adequate to portray the major findings that have emerged from our data.

Internal consistency reliabilities, as measured by Coefficient Alpha, were uniformly high for all five instruments. Means for true/false and two-option multiple-choice tests were almost identical, whereas the mean for the three-option multiple-choice test was slightly lower, as would be expected theoretically by the presence of an additional distractor. Standard deviations for all three knowledge tests were nearly identical.

Means on the behavior rating form and the applied performance test were very similar to each other and both somewhat lower than means on the knowledge tests. Variabilities of the behavior rating form and applied performance test were similar to each other and, proportionally, slightly larger than the variabilities of the knowledge tests.

As might have been expected, the intercorrelations among the three knowledge item formats were moderately high, generally in the .80s for all domains but Job Search, in which intercorrelations ranged from .58 to .68. Perhaps somewhat surprisingly, the correlations between the knowledge tests and applied performance were almost as high, whereas single-order correlations between behavior rating and applied performance were definitely lower, ranging from .47 for the banking area to .56 for the total of all domains. The correlations between knowledge tests and behavior ratings were lower still, in the .30s and .40s for all content areas. In each case, the multiple correlation regressing knowledge and behavior rating upon applied performance yielded a value only slightly higher than the correlations between knowledge alone and applied performance.

The large magnitude of the relationships that have emerged from these findings is somewhat surprising. Moreover, the apparent superiority of knowledge testing over behavior rating was not anticipated. Who would have predicted that a true/false test of 15 minutes duration would account for 25% more criterion variance than a behavior rating measure derived from a one-hour interview with parents?

These findings have been verified through cross-validation and suggest, generally, that direct testing should play a stronger role in the future measurement of adaptive behavior than has been characteristic of the past. By exploring test formats that may be appropriate for student evaluation in career education programs, this project has produced results which identify, more clearly than before, guidelines for selection of measurement strategies that can be used appropriately by all who are involved in the education and vocational rehabilitation of mildly retarded citizens.

APPLICABILITY: The specific findings in the current project have a great deal of potential utility. Prior to this project, little progress had been made toward the development of classroom-appropriate applied performance tests for retarded adolescents and young adults in career education programs. This project has resulted in a model for development of such measures, as well as

prototype, fully-developed, data-based-applied performance tests in three career education domains.

In addition, this project has provided strong empirical support for the utility of the Center's previously developed and widely used **Social and Prevocational Information Battery** (SPIB). The results demonstrate that a direct testing approach, such as that employed by SPIB, has substantially more validity for predicting applied performance skills than does the behavior rating approach which constitutes much of current assessment practice with retarded adolescents and adults.

209 Pilot Study on Overdependence in Mildly Retarded Adolescents: A Structural Family Therapy Analysis

Principal Investigators:	Philip Browning, Ph.D. Elizabeth Hunt, M.A.
Status:	Completed
Dates:	October 1977-February 1980
Cost:	Annual \$12,198 RT Annual \$12,198
	Projected Total \$15,000 RT % of Annual Total 100%
Annual Report References:	#13, Page 111, R-45 #14, Page 104, R-45

OBJECTIVES: The purpose of this study was to investigate the relationship between parents and their adolescents in families of independent and overly dependent mildly retarded adolescents. Specifically, the objectives of the study were:

1. To determine if a set of identified behavior variables comprise any family interaction patterns (the relationship between adolescent and parent) with overdependence and independence in mildly retarded adolescents; and
2. To determine if a set of identified behavior variables comprise overdependence and independence in mildly retarded adolescents or their respective parents.

METHODOLOGY: Three independent and three dependent subjects were chosen for this study from a pool of 49 mentally retarded adolescents (ages 16-21) living with their family of origin. They were selected on the basis of concurring with all five criteria measures related to whether the subjects were dependent or independent: (1) counselor/teacher judgment based on a set of dependent/independent criteria; (2) extreme scores (high-low) resulting from the Highlands Dependency Questionnaire, which was administered to the mother; and (3) the independent judgment of each of three family clinicians using a 4 point Likert scale.

Each subject and his/her mother was asked to engage in a 20 minute Family Problem Solving Task which consisted of agreeing upon planning an outing (what, where, when, how long, and what preparation?). Each 20 minute Family Task was videotaped. These videotapes were then subjected to an interactional coding system.

The Marital Interaction Coding System (MICS), which has been adapted for use with adolescents and their family members, is designed to sequentially code all verbal and non-verbal behaviors in a problem-solving setting. The system is comprised of 28 behaviors which, based on prior research, can be clustered into the following five behavioral domains: (1) Problem-Solving; (2) Positive Verbal; (3) Positive Non-Verbal; (4) Negative Verbal; and (5) Negative Non-Verbal.

FINDINGS TO DATE: Both research questions, one and two, were addressed by subjecting the data to a frequency/percentage analysis across the five behavioral domains derived from 28 specific coded behaviors: (1) Problem Solving; (2) Positive Verbal; (3) Positive Non-Verbal; (4) Negative Verbal; and (5) Negative Non-Verbal. The following statements reflect the results of this analysis.

Research Question One: Dependent adolescents did less "Problem Solving" in conversation with their mothers than did independent adolescents. Independent adolescents' frequency and percentage of their total conversation devoted to Problem Solving more closely approximated mothers' frequency and percentage spent on Problem Solving.

Proportionately speaking, not much time was spent on Positive Verbal statements. However, there was a trend for dependent adolescents to make somewhat less Positive Verbal statements than their mothers did. Independent adolescents, on the other hand, made somewhat more Positive Verbal statements than their mothers did.

There was considerable Positive Non-Verbal activity for adolescents and for mothers in both groups. There was a tendency for dependent adolescents to do more Positive Non-Verbal behaviors than their mothers in absolute frequencies while the relative percentage of the conversation for each was the same. Independent adolescents, on the other hand, did less Positive Non-Verbal behaviors than their mothers in both frequency and percent.

For Negative Verbal statements independent adolescents made more such negative statements than their mothers in both frequency and percent. For dependent adolescents, while the absolute frequency was slightly higher than their mothers, the percentage of their behaviors coded at Negative Verbal was slightly less than their mothers.

Both dependent and independent adolescents engaged in more Negative Non-Verbal activity than their mothers. However, for independent adolescents this was only slightly true; whereas for dependent adolescents both their frequency and percentage of total behaviors was notably greater than their mothers.

Research Question Two: Dependent adolescents engaged in less Problem Solving than did independent adolescents. Mothers of dependent adolescents engaged in more problem solving than did mothers of independent adolescents.

The level of Positive Verbal activity for both independent and dependent adolescents was small. However, the trend was that dependent adolescents made less Positive Verbal statements than did independent adolescents. Interestingly, mothers of both groups had the same level of Positive Verbal activity regardless of whether the adolescent was independent or dependent.

Dependent adolescents showed more Positive Non-Verbal activity than independent adolescents. Mothers of dependent adolescents were involved in less Positive Non-Verbal activity than were mothers of independent adolescents.

Negative Verbal behaviors were less frequent in dependent adolescents than in independent adolescents engaged in only a slightly greater percentage of Negative Verbal activity than did mothers of independent adolescents.

Dependent adolescents engaged in much more Negative Non-Verbal behavior than did independent adolescents while the trend for mothers was not consistent.

APPLICABILITY: The findings of this project will yield three major implications for practice changes. First, they will provide vocational trainers with a behavioral assessment of performance on specific task criteria rather than a global assessment of work abilities. Second, they will produce a validated set of predictor variables which could increase the accuracy of significant managerial decisions. And third, they will derive from a population not previously considered as potential candidates for sheltered workshops.

210 Predicting Rate of Acquisition and Production of Complex Industrial Tasks by Institutionalized Moderately and Severely Retarded Adults

Principal Investigator:	Larry Irvin, Ph.D.	
Status:	Continuing	
Dates:	July 1974-July 1980	
Cost:	Annual \$10,998 RT Annual \$10,998	Projected Total \$185,000 RT % of Annual Total 100%
Annual Report References:	#13, Page 76, R-31 #14, Page 60, R-31	

OBJECTIVES: To revise the Trainee Performance Sample in order to:

1. increase the range of appropriate examinees to include individuals classified as low-moderate mentally retarded, as well as severely/profoundly retarded;
2. establish content/construct validity—that is, to sample within the test in a systematic fashion, type of task and type of instruction dimensions; and
3. examine thoroughly the reliability and concurrent validity of the revised scale.

METHODOLOGY: A content grid was developed to guide TPS revision. The three components of the grid were type of instruction, task attributes, and number of objects involved in the task. Three different types of item instructions—model/match-to-sample, physical prompts, and verbal directions—were systematically integrated into revised TPS items. These instructional strategies are the three types of training procedures commonly employed in vocational training for severely retarded adults. The task attributes—minimal difference, coordinated two-hand movement, if-then rule, sequencing, conjunctive stimulus control—evolved out of contemporary thinking regarding task analyses of vocational tasks. These seem to serve well as difficulty descriptors for vocational tasks. The third dimension of interest in TPS revision was number of objects within each task. This component has less of a theoretical rationale; rather, it serves to guarantee a variety in types of test items, e.g., physical manipulation without objects as well as more difficult tasks with one or two objects. Via use of the grid as a blueprint for item generation or revision, a total of 30 revised or newly developed items were field tested.

One hundred forty-nine adults classified as profoundly retarded, severely retarded, or low moderately retarded were identified as project participants in May 1978. Selection for participation was based on facility willingness to participate. All 10 facilities that were initially contacted agreed to be involved; eight were community-based work facilities and two were institutions—one state and one private. Fifty-four percent of the individual participants were enrolled in community work activity centers and 46% in residential institutions. A sample of 26 community-based participants was retested two weeks after the original test.

Concurrent validity of the revised TPS was also ascertained. A Supervisor's Checklist was developed with items relevant for severely/profoundly retarded workers. Four major categories of work behaviors commonly correlated with vocational success were used as guides to item development: stability of worker's performance, ability to follow instructions, social/cooperation and peer relation skills, and coordination and physical dexterity skills. Each item was a behavioral statement such as, "Responds to simple verbal directions without requiring further assistance," or "Performs tasks which require the use of a hand tool, such as a screwdriver, with minimal assistance." Each statement was followed by a 3-point rating scale, most of which involved frequency ratings ("usually or always," "sometimes," "seldom or never"). Supervisors' ratings of retarded workers on the Supervisor Checklist were then correlated with revised TPS scores.

In addition to applications with institution- and community-based individuals, it was important to examine the utility of TPS with younger (adolescent) severely/profoundly retarded persons to determine whether as age (and relevant experience) decrease, TPS remains sensitive to vocational skill differences among retarded individuals. Accordingly, a large secondary-level educational service district in the Eastern U.S. (services to 19 school districts) was selected on the basis of widely available and willing participation of severely and profoundly retarded adolescents. Students' classification as severely or profoundly retarded by the school district was on the basis of IQ/SQ, adaptive behavior, and institution referral records. Ages of these participants ranged from 12 to 22, with mean median and mode between 17.0 and 17.5. TPS tests were administered by qualified psychological services professionals within the education service district to project participants.

FINDINGS TO DATE: Results indicated adequate psychometric characteristics for the revised TPS. Mean difficulty level was 59% correct for the total sample of 149 examinees. The standard deviation was 15.6. Item to total test correlations were also computed for each item. These Pearson r 's ranged from .20 to .78, with 21 items having such item validity indices in the .50 to .69 range. Coefficient Alpha internal consistency reliability for the 30-item revised TPS was $\alpha = .95$. Test-retest reliability was $r = .92$ for $N = 26$.

Data-based measures of appropriate TPS content/construct validity also emerged from 1977-78

project activities. One index was the disparity between scores of institutionalized and community-based examinees. Experiences related to TPS tasks are clearly more readily available in community workshop/activity center settings than in typical institutional prevocational training programs. The revised TPS appears quite sensitive to these experience-related effects; the mean total revised TPS score for 81 institution residents was 71% correct, while that for 68 institution residents was 45%.

The second major data-based outcome related to content/construct validity involved the potential utility of subscales within the revised TPS. As would be predicted, the 10 items which were presented with verbal instructions only were more difficult for all TPS examinees than were the 20 items presented with verbal plus modeled and/or physically prompted cues. The average percent correct was 56% on verbal only, 60% on verbal plus modeled, and 61% on verbal plus modeled and physical prompts. As with total TPS scores, community-based examinees scored substantially higher than institution residents on each "subscale."

The results of the concurrent validity study indicated that the relationship between all institution residents' revised TPS scores and Supervisor Checklist scores was $r=.60$ ($N=68$), while that for all community-based participants combined was $r=.64$ ($N=81$), indicating moderately high agreement between TPS scores and supervisors' perceptions of retarded workers' skills/performance.

Additionally, on all important dimensions—difficulty, variability, and reliability—the revised TPS appears psychometrically adequate when used with severely/profoundly/retarded (SPMR) adolescents. Total scale average difficulty level was 38% correct. When considered in the context of previously described data regarding TPS difficulty ($\bar{x}=71\%$ correct for 81 SPMR community residents, and $\bar{x}=45\%$ correct for 68 SPMR institution residents), the difficulty of TPS for SPMR adolescents is as predicted, i.e., most difficult for those who would be expected to be lowest functioning because they are younger and less "vocationally" experienced.

The relative difficulty of TPS subscales, "verbal instructions" only vs. "verbal plus modeled instructions," is also as predicted. That is, items with verbal instructions only were most difficult ($\bar{x}=30\%$ correct), items with verbal and modeled instructions were next most difficult ($\bar{x}=39\%$), and items with verbal plus modeled and prompted instructions were "easiest" ($\bar{x}=55\%$ correct).

The Coefficient Alpha internal consistency reliability estimate for the revised TPS with the Pennsylvania adolescent sample was $\alpha=.92$. For the three subscales, Coefficient Alpha internal consistency reliability estimates were: verbal instructions only— $\alpha=.76$; verbal plus modeled instructions— $\alpha=.86$; verbal plus modeled and physically prompted instructions— $\alpha=.81$.

211 Supervision in Vocational Rehabilitation

Principal Investigator:	William English, Ph.D.	
Status:	Continuing	
Dates:	May 1976-February 1980	
Cost:	Annual \$61,992 RT Annual \$61,992	Projected Total \$300,000 RT % of Annual Total 100%
Annual Report Reference:	#13, Page 145, R-40	

OBJECTIVES:

1. To describe the supervisory process in vocational rehabilitation.
2. To implement, through an original research utilization project, the findings of the proceeding descriptive study of first-line supervision in vocational rehabilitation agencies.
3. To effect widespread dissemination and utilization of the implementation project in public vocational rehabilitation agencies in a multi-regional area.

METHODOLOGY:

1. **Literature review.** Books, periodicals, and manuscripts are being reviewed from a variety of sources to gather the best possible picture of a number of supervision issues, e.g., selection, training, theory, practice, and outcomes.

- 2 **Individual interviews.** On-site interviews are being conducted with vocational rehabilitation counselors, supervisors, managers, and administrators to supplement data collected via questionnaires and small group need assessment procedures. An interview schedule was developed as a stimulus tool for use in interviewing.
- 3 **Nominal group process exercises.** This on-site procedure consists of the identification of a need area, which is presented to a small group — usually 10-15 vocational rehabilitation personnel. A useful item in this research has been: "List 4 suggestions which, if implemented, would increase the effectiveness of first-line supervisors." The group is then directed by experienced facilitators through four steps: problem identification, listing of problems, clarification and revision of problems, and problem resolution.
- 4 **Questionnaires.** Survey questionnaire booklets consisting of questions concerned with supervisory selection practices, training, evaluation, and how supervisors assist counselors to rehabilitate retarded clients have been mailed to a stratified random sample of counselors, supervisors, managers, and administrators employed in more than 40 general vocational rehabilitation agencies.
- 5 **Data analysis.** Questionnaire data was analyzed through the use of the Statistical Packages for Social Sciences (SPSS) program, which yielded adjusted frequency percentages for each item and for each personnel group (Administrators, Supervisors, and Counselors). The adjusted percentage data was also subjected to tests of statistical significance using the Chi Square method, to examine differences between personnel groups as they might be influenced by the following intervening demographic variables: (1) state agency size; (2) age; (3) years in the VR agency; and (4) level of academic degree.

FINDINGS TO DATE: Currently the most important influences on being selected as a rehabilitation counselor supervisor are a previous work record with a local agency manager and a successful existing relationship with those state agency administrators, managers, and supervisors responsible for making the selection decision. Agency professionals would like future selection procedures to be more objective, emphasizing the following criteria: (a) leadership ability, (b) personality characteristics, (c) case management skills, (d) previous work experience, and (e) educational training.

Professionals (administrators, supervisors, and counselors) believe that counselors need assistance in understanding and anticipating the position of first-line supervision and that such assistance should be provided within one year after the person joins the agency.

Two major problems that presently interfere with the state agency's supervisory selection procedures are lack of effective supervisory development programs and lack of validated objective selection criteria.

Rehabilitation professionals at all personnel levels want the agency to have almost complete internal control over supervisory selection, independent of civil service or other state departments. This theme is reflected in findings that indicate that the agency is not receptive to selecting supervisors from outside the agency, that supervisory candidates should have two- to three-years work experience as agency counselors, and that the agency wishes to develop its own criteria and procedures for selecting supervisors.

Supervisory Practices: The most important supervisory role is that of counselor education/consultant. Supervisors currently spend most of their work time in administration and case consultation. These two supervisory roles would continue to receive primary emphasis under ideal working conditions, although supervisors would devote more time to case consultation and less time to administration.

Professionals believe that state rehabilitation agencies provide good/excellent physical facilities for supervisors to conduct individual and group consultation with case-service staff, and that supervisors are highly accessible to case-service counselors for consultation.

Approaches or methods of supervising counselors in rehabilitation case management are primarily limited to individual case review and field observation.

Professionals believe that supervisors' job responsibilities exceed their authority in almost all areas of administrative job functioning.

Rehabilitation professionals, especially administrators and counselors, believe first-line supervisors

do a poor job in many functional areas of counselor consultation and counselor evaluation. Professionals think that democratic leadership is the best choice for persons at all levels of rehabilitation agency leadership—supervisors, middle managers, and top-level administrators.

To be successful, professionals believe that it is very important for rehabilitation supervisors to display the following seven characteristics: personal honesty, leadership, efficiency, concern for others, concern for state regulations, flexibility, and decisiveness.

The five criteria ranked as most important in supervisors' "current" evaluations of counselor work performance are attainment of production goals, compliance with state agency policies, quality of case recording, quality of individual written rehabilitation plans (IWRPs), and subjective judgment. These criteria would apply under ideal agency conditions, but new emphasis would be given to counselors' own professional growth and less to subjective judgment and the attainment of production goals.

Supervisory Training: Professionals believe their agencies are not providing adequate resources for training rehabilitation counselor supervisors and approximately one-half are dissatisfied with the quality of supervisory training.

The largest obstacle to improving supervisory training is competing time demands between production and training.

Administrators, supervisors, and counselors believe training would improve supervisors' job effectiveness.

Agency professionals believe that training for rehabilitation supervisors should begin when a person becomes a first-line supervisor or shortly after they reach civil service eligibility.

Basic management and human relations/communication are recommended as the two most important curriculum areas to be included in both long-term and short-term training programs for rehabilitation supervisors.

Professionals believe it is important that persons above and below the level of first-line supervisors should receive similar supervisory training experiences.

Recommended criteria for evaluating the effectiveness of short-term supervisory training are improved job efficiency, better staff communications, more satisfied clients, and improved staff morale.

Rehabilitation agency professionals are personally supportive of the development of new long-term academic education programs for supervisors, although they believe that agency support for such programs is contingent on outside funding. If new long-term supervisory education programs are developed, most professionals prefer that the programs have a very strong applied clinical training emphasis, that the programs be designed for current agency counselors or supervisors, and that full-time study in supervision lasts no more than a calendar year.

Supervisory Evaluation: The present evaluation system is believed to be ineffective in decisions about supervisory merit increases, demotion, and termination. Factors considered as very likely to result in a supervisor's termination are supervisors ignoring agency policy procedures, acting highly inefficient, or being very vocal against agency regulations.

Middle managers are perceived as having the greatest influence on the development of supervisory evaluation criteria and the greatest responsibility for evaluating first-line supervisors.

Administrators, supervisors, and counselors rate the following nine evaluation criteria as being very important to supervisory evaluation, in current and ideal conditions: budget management, increasing counselors' successful closures, unit efficiency, planning, case consultation with staff, counselor evaluation, liaison activities, staff morale, and training/staff development.

Two major problems identified as obstacles to the improvement of the supervisory evaluation system are the lack of validated objective evaluation criteria and the lack of validated subjective evaluation criteria.

Supervision of Counselors' Work with Retarded Persons: Many administrators (38%), supervisors (39%), and counselors (46%) believe that the expected successful closure rate for retarded persons should be lower than the rate for other disability groups.

The process of supervising counselors' work with retarded persons is believed to be the same as the supervision process of counselors who work with other disability groups.

Administrators, supervisors, and counselors state that supervisors should receive special training to assist counselors who work with retarded persons. Areas of highest training priority are the etiology of mental retardation, job development/placement, community adjustment and community resources, general assessment, general counseling, behavior modification, and family adjustment counseling.

Generic Process Findings: Across 43 states studied, the typical rehabilitation counselor supervisor is a 39-year-old male with a bachelor's degree in psychology or sociology and a master's degree in rehabilitation counseling. He has worked more than 11 years in the rehabilitation field, over 9 years in a vocational rehabilitation agency, and 5 years as a rehabilitation counselor supervisor. He supervises an average of seven counseling staff, and approximately three out of those seven have case loads comprised of 20 percent or more retarded clients.

Professionals are dissatisfied with the quality of their agencies' supervisory selection, training, and evaluation procedures but are optimistic that realistic improvements can be made.

Professionals are satisfied with the amount of time they spend verbally communicating with peers, paraprofessionals, clients, and clients' families. Approximately one-fourth, however, wish to increase their verbal communications with agency-related persons with whom they interact.

As discrete professional groups, rehabilitation administrators and supervisors tend to share more views with each other than they do with counselors. One major exception is supervisory practices, in which administrators and counselors express similar views that are more critical than supervisors' self-perception. Generally counselors are most critical about all aspects of supervision and least hopeful that supervision can be improved.

APPLICABILITY: This project holds four implications for policy, program and practice changes in vocational rehabilitation. First, it will influence the professional knowledge and skills of first-line supervisors. Second, it will provide administrative leaders with a data base for considering change in the state agencies' present system of first-line supervision. Third, study materials will be of assistance to specialists responsible for the selection, training and evaluation of supervisors. Fourth, it will help rehabilitation counselors to be better consumers of supervisory practices.

212 Evaluation and Training of the Severely/Profoundly Handicapped for Community Adjustment

Principal Investigator:	Daniel Close, Ph.D.	
Status:	Continuing	
Dates:	September 1977-August 1982	
Cost:	Annual \$100,000 RT Annual \$2,695	Projected Total \$475,000 RT % of Annual Total 3%
Annual Report References:	#13, Page 97, R-47 #14, Page 84, R-47	

OBJECTIVES:

1. Determine the content of the preliminary form of assessment instrument in four domains of self-care, domestic, mobility, skills, and communication skills;
2. Task analyze the content identified in the four domains of self-care, domestic, mobility and communication skills into component parts to serve as a basis of item sampling;
3. Determine the level of complexity of the component parts of the task analyzed skills in the four domains to guide item sampling;
4. Develop an item sampling strategy;
5. Develop and evaluate a preliminary form of the assessment scale in the self-care and domestic domains;

6. Develop and evaluate preliminary forms of assessment scale in the mobility and communication skills domain;
7. Develop the final form of the assessment scales in all four domains;
8. Validate the final form of the assessment instrument for severely retarded adults;
9. Develop an assessment and training manual and an accompanying curriculum guide in the content area of self-care, domestic care, basic mobility, and communication skills for severely retarded adults; and
10. Evaluate the impact and utility of the assessment scale, the assessment and training manual, and the accompanying curriculum materials.

METHODOLOGY: Project staff reviewed four behavior checklists to determine the content of the preliminary form of the instrument. These instruments included: AAMD Adaptive Behavior Scale, Progress Assessment Chart, Independent Living Skills Assessment System, and the Camelot Behavioral Checklist.

The initial in analyzing content of the scale was to reduce each task identified in Objective 1 into individual "core skills." These "core skills" are the individual steps necessary to teach or perform the task. Next project staff organized the content into larger groups of behavior called "functional units." This was done because much training with severely retarded persons is accomplished with short sequences of skills rather than with individual "core skills." Finally, project staff grouped the content into still larger segments of 2-3 "functional units" labeled "extended clusters." "Extended clusters" were developed in an attempt to increase the ceiling of the assessment instrument.

Task complexity was determined by a three-stage process. The first step in the process was to produce detailed operational definitions of the dimensions of task complexity. These detailed operational definitions were used by knowledgeable raters to rate the complexity of task content on a two-point rating scale. Finally, the results were analyzed to determine a hierarchy of task complexity.

An item sampling strategy was developed to convert a representative sample of the content into actual test items. The item sampling procedure was designed to represent: (1) two levels of complexity (simple and complex) in both the manipulation and discrimination dimensions of all domains; (2) the core skills in relation to their proportion in the domains; and (3) different lengths of items in all domains, e.g., "core skills," "functional units," and "extended clusters."

A preliminary form of the assessment scale was then developed based on the outcomes of activities addressed in Objectives 1-4. This pilot version of the scale contains approximately 150 items that are fully task analyzed, and that are scripted into three presentation formats (verbal instructions, modeled instructions, and physically prompted instructions).

In order to determine the psychometric characteristics of the preliminary form of the self-care and domestic scales, project staff administered the scale of 75 severely retarded adolescents and adults who are involved in educational programs in the Northwest. Test administration occurred in the educational program settings where the participants live or attend school.

Based on the outcomes of the preliminary field test of the Self-Care and Domestic scales, necessary revisions in content and complexity analyses will be made in the remaining two domains of communication and mobility. In addition, any necessary modification of the item sampling strategy will be made. Pilot versions of scale components in the communication and mobility domains will then be constructed and administered to a sample which is the same as or similar to the group involved in the pilot of the self-care and domestic segments of the scale. Project staff will then develop the final form of the instrument on the basis of information provided by the evaluation of the preliminary forms of the assessment scale in all four domains.

Following development of the revised form of the instrument in four domains, a sample of 150 severely retarded adolescents and adults will be selected. The purpose of these activities is to produce full standardization and normative data on the tests in all four content domains. Project staff will modify or eliminate test items, and revise item formats on the basis of statistical analyses of standardization data. The result of these activities will be final forms of tests in all four content domains.

Project staff will individually train a sub-sample of 50 severely retarded individuals, who have been tested during the instrument standardization activities, on a sample of tasks from each of the four content domains. One-third of the tasks will be presented at the level of difficulty and with the training modality indicated by the outcomes of the diagnostic assessment. Another one-third of the tasks will be presented at the level of difficulty indicated by the assessment outcomes, but with a higher level (less informative) training modality than was indicated. The final one-third of the tasks will be presented with the indicated training modality, but at a higher difficulty level than was indicated by the outcomes of the diagnostic assessment. Training will be continued until criterion performance is achieved, or the number of unsuccessful trials reaches a point where it is safe to assume that further similar training will not facilitate criterion acquisition.

This task will require the writing of an introductory section to the training manual, instructions concerning administration of the assessment scale, and a curriculum guide that specifies the methods to be used to teach the skills included in the assessment scale.

Approximately 25 teachers and community residential facility program personnel will use the comprehensive assessment and training kit for a period of six months with approximately 125 of their adolescent and adult severely retarded students/residents. An intensive in-service training workshop for participants will precede the field testing activities.

Questionnaire and actual training achievement data will be collected from all participants in the field test in order to evaluate several aspects of the materials: (1) the clarity and organization of all materials; (2) user satisfaction with method of test presentation and assessment outcome information; and (3) training achievement following use of the instrument and accompanying instructional intervention.

FINDINGS TO DATE: Specific results of this project include: all content was analyzed into "core skills," "functional units" and "extended clusters." Each of these units of behavior were analyzed into two levels of complexity. The product of this activity was a detailed complexity rating of all content along and easy-to-hard sequence.

A preliminary form of the assessment scale was developed based on: representation of core skills across all domains; complexity ratings; and different item lengths. The preliminary form of the scale is currently being administered to 75 severely retarded persons. Results of this field test will be available at a later date.

APPLICABILITY: The instruments, manuals, and training kit produced by the proposed project will be developed specifically for use in the rehabilitation of severely and profoundly retarded persons. This system will allow program managers to use evaluative information to estimate the amount of time and resources needed to develop client skills to an acceptable level. The information obtained from the assessment instrument will facilitate the habilitation of severely/profoundly retarded people because the training programs presented are directly related to the skills assessed and to the varying skill levels observed. This will aid program managers in individualizing program planning and monitoring progress in training activities. Skill deficits will be defined as service priorities instead of client deficiencies.

An added benefit of the proposed project is that the instruments, manuals, and training procedures will function as a self-contained training program for service providers and rehabilitation counselors. By informing the rehabilitation counselor of the necessary content and procedures needed to prepare severely/profoundly retarded clients for community adjustment, the entire rehabilitation process is facilitated. Rehabilitation counselors will further be able to use the training kit to train paraprofessional workers to deliver high quality assessment and habilitation services to severely and profoundly retarded clients.

213 Utilization of the Social and Prevocational Information Battery (SPIB)

Principal Investigator: Larry Irvin, Ph.D.
Status: Continuing
Dates: March 1978-June 1979
Cost: Annual \$6,661
RT Annual \$6,661
Annual Report Reference: #13, Page 59, R-49

Projected Total \$23,000
RT % of Annual Total 100%

OBJECTIVES:

1. To ascertain ways in which SPIB is being utilized by a representative sample of users across the country with respect to:
 - a. student/client diagnosis and classification;
 - b. individual program planning;
 - c. program monitoring; and
 - d. program evaluation.
2. To update and improve the SPIB test materials.
3. To provide the basis for the content of a campus workshop on SPIB utilization.

METHODOLOGY: Sample selection. CTB/McGraw-Hill records of SPIB distribution and sales from September, 1975, to October, 1977, indicated that SPIB was being purchased by school districts and a variety of other educational and rehabilitation agencies nationwide. These records also showed that the smallest purchase order by a single SPIB user was 20 tests and the largest was 10,000.

Further examination of the distribution and sales data resulted in the identification of two broad dimensions that could be used to describe the SPIB-purchaser population. First, by the 10 federal regions that described their geographical location. Secondly, according to the size of their SPIB test booklet purchase orders: 20-40, 60-80, 100-200, and more than 200 test booklets.

After classification by geographical region and purchase order size, a stratified random selection of one-third of all SPIB purchasers was completed. Via this process, 204 school districts and rehabilitation/education agencies that had purchased SPIB were identified as potential participants. Ten other locations of special interest because of large purchase orders were later added, increasing the sample to 214 sites.

Telephone calls were made to each potential site. If a potential site chose not to participate, replacement procedures were effected to locate another equivalent site. Successful location of sites was followed by letters to further explain the project objectives and to request a listing from the contact person of all people who had actually administered SPIB.

Questionnaire development and distribution. A questionnaire on SPIB utilization was developed to solicit a variety of information from SPIB users. Questions were formatted to require only check-marks in response, and to provide space for additional comments.

Questionnaires were mailed to each of the 686 individuals who had been identified as SPIB users in the 214 locations sampled. Recipients were asked to fill out the questionnaire and return it in a stamped, addressed envelope provided along with the questionnaire.

Data analyses. Using the sampling stratification categories, data were classified and analyzed by respondents' geographical region, by test booklet purchase order size, and by job title of respondent.

In summary, the sampling process produced 285 completed questionnaires from 95 locations scattered throughout the 10 regions of the country. Of the 686 potential participants, 227 were determined to be inappropriate recipients of the questionnaire for two reasons. First, though some had purchased SPIB, they had not used it. Secondly, some had not heard of SPIB, though their employment location had purchased some SPIB materials. As a result, the return rate from appropriate questionnaire recipients was 62%. Approximately 55% of the locations where SPIB actually had been used were represented by the 285 returns. The return rate varied from 35% to 75% by region. Of the 40 sub-sample groups identified by region (10) and purchase size (4 levels), only 2 were unrepresented after all questionnaire returns. In one case there were 3 potential participants and no returns, and in the other there was 1 potential respondent who did not complete a questionnaire.

FINDINGS TO DATE: Student groups assessed with SPIB. Analysis of responses to the first three items of the questionnaire revealed that SPIB has been administered to a variety of student groups, differentiable by grade level, handicapping condition, and ethnicity. With respect to grade level, SPIB has been administered more often to students in grades nine and above than to those in grades eight and below. This is not surprising because SPIB was developed to be administered primarily to mildly retarded (EMR) secondary level students in work-study programs.

Most of the respondents (94.9%) said that SPIB had been administered to mildly retarded (EMR) students, and 37.7% indicated that learning disabled students were often assessed. About 20% of the respondents indicated that SPIB had been used with moderately retarded (TMR) or emotionally handicapped students. (An experimental version of SPIB for moderately retarded or TMR students was developed in 1977. Named "SPIB - Form T," it will be published by CTB/McGraw-Hill in 1979.)

Four other handicapped student groups have also been tested occasionally with SPIB. In order of descending frequency, these groups were physically handicapped students tested by 63.2% of the respondents, cerebral palsied students (43.4%), deaf students (18.4%), and visually impaired students (6.6%).

Program planning at the individual group level. Although more than one-half of the respondents (56.1%) answered that the *SPIB User's Guide* had been used in general program planning and development, an even higher proportion (67.1%) reported that SPIB materials had been used satisfactorily to help develop Individual Educational Programs (IEPs) for students. For example, SPIB was widely accepted for IEP-related uses in several ways: as an aid for gaining parent participation in the development of programs (70.0% of the respondents so responding); in justifying placements or documenting student needs (61.6%); in identifying student's academic goals (85.3%); in writing short-term objectives (87.4%); and in helping to select, develop, or modify materials to meet IEP objectives (60.2%). SPIB test results or content definitions were not typically used to help revise IEPs between annual IEP meetings. Further, only 47.8% of the respondents answered that SPIB information had been used in making annual revisions or evaluations of student's IEPs. In concluding the questionnaire about IEPs, many respondents suggested that additional materials, such as curriculum guides, would make SPIB an even more useful tool in helping to complete the IEP development and implementation process.

Selecting and development materials in SPIB domains. Close to half of the respondents answered that SPIB test results or content definitions had been used to select (48.0%) or develop (49.8%) curriculum materials for programs. When asked in what specific areas materials had been developed, respondents noted relatively high activity in all SPIB domains. Materials were most often developed in the areas of Banking, Job Related Behavior, Budgeting, and Job Search Skills, and least often developed in the areas of Health Care and Home Management.

Most of the total respondent group noted that their interpretations of SPIB results for program evaluation had been very or moderately useful (29.3% and 62.1%, respectively). Only 8.6% said their applications of SPIB for program evaluation had been slightly useful.

Technical concerns in SPIB utilization. The percentages of respondents who reported finding ambiguous test items or items too difficult for students because of vocabulary, syntax, content, or concepts is low, ranging from 22% to 35%. In very few cases was the same item identified by three or more people to be problematic. Overall, SPIB's answer formatting was considered to be appropriate; there were few people, less than 10%, who were in favor of changing the present "True-False" format to "Right-Wrong." In general, SPIB tests do not typically take longer than 20 minutes to administer, and most respondents felt that oral administration of the test was appropriate. In each of these areas, then, the finding has been that most respondents have found SPIB to be quite appropriate and satisfactory for the student groups they normally test.

Close to half of the respondents (43.7%) reported similarity between the reference group performance norms presented in the *SPIB User's Guide* and the performance of their own students. About 10.3% found the *User's Guide* norms to be lower than their own students' performance, 28.1% found these norms to be higher than their students' performance, and 17.9% reported that the *User's Guide* norms had not been considered.

Future needs with SPIB. One of the final questions presented in the SPIB Utilization Questionnaire asked about the desirability of developing a *SPIB User's Information System* and about the types of information SPIB users would like to have available. Respondents rated all of the following six possible sources of information as "very" or "moderately" useful: (1) SPIB-related curricula developed by other schools and/or districts; (2) commercially available SPIB-related curricula identified by other SPIB users; (3) SPIB norms made available from other similar size school districts; (4) IEP development procedures in SPIB domains; (5) additional needs assessment procedures for SPIB; and (6) program or student evaluation procedures in SPIB domains.

APPLICABILITY: Rehabilitation policy setters have long believed that vocational objectives for mentally retarded clients cannot be accomplished in the absence of social and community adjustment. SPIB diagnostic results provide rehabilitation service providers with specific and appropriate information for developing client objectives in social and prevocational domains.

214 A Sociological Look at Retarded Person's Perceptions of the World of Work

Principal Investigators: Philip Browning, Ph.D.
Ray Nelson, M.S.

Status: Continuing

Dates: March 1978-February 1980

Cost: Annual \$8,515
RT Annual \$8,515
Projected Total \$15,000
RT % of Annual Total 100%

Annual Report References: #13, Page 279, R-51
#14, Page 275, R-51

OBJECTIVES: The purpose of this study is to conduct a sociological inquiry into the world of competitive employment from the perspective of mentally retarded persons. Specifically, sociological qualitative methodology will be employed to implement the following objectives:

1. to investigate the potential influence of four areas upon mentally retarded persons' perceptions of the world of work. The four areas or factors which may influence retarded persons' perceptions are: family interaction, peer interaction, job interaction, and social/leisure interaction; and
2. to search for theoretical assumptions and paradigms which will enable us to better understand the impact of being a retarded worker in this society.

METHODOLOGY: Thirty-three mildly retarded persons were selected from a pool of over 250 such persons who participated in a job search skills program funded by CETA and the Oregon Association for Retarded Citizens. Twenty-eight subjects comprised the final sample.

Each subject was interviewed on five separate occasions. The interviews were conducted using five in-depth focused interview schedules related to the content areas of: (1) Basic Information; (2) Work; (3) Family; (4) Social and Leisure Interaction; and (5) Peers and Daily Interaction.

FINDINGS TO DATE: A total of 140 taped interviews (46½ hours of listening time) were conducted with 28 mildly retarded adolescents over an eight-month period. Extensive "field notes" were taken throughout this process to supplement the data bank. The data are currently being subjected to both quantitative and qualitative analysis.

APPLICABILITY: Such knowledge has the possibility of enhancing our methods for improving the work role for retarded people so that they may participate more fully as productive members of the community. This type of consumer-based information has definite implications for pinpointing previously unforeseen problems as they pertain to retarded workers. This increased understanding of their perception of the work world has the potential of facilitating and increasing our communication with an understanding of retarded people.

215 Identification of Leadership Characteristics of "Successful" Supervisors in Vocational Rehabilitation

Principal Investigator: William English, Ph.D.

Status: New/Continuing

Dates: January 1979-December 1980

Cost: Annual \$33,546
RT Annual \$33,546
Projected Total \$70,000
RT % of Annual Total 100%

Annual Report References: #13, Page 170, R-52
#14, Page 201, R-52

OBJECTIVES: The purpose of this study will be to identify whether specific leadership factors are more prevalent amongst more successful, versus less successful first-line rehabilitation supervisors. A critical product to be developed in this project is an instrument which will measure the presence or absence of important activities related to the successful practice of rehabilitation supervision.

The research questions that relate to this project, and which extend this statement of purpose are:

1. Is it possible to operationally define "successful" performance of first-line supervisors employed within the general state/federal vocational rehabilitation agency?
2. Do more successful versus less successful vocational rehabilitation supervisors exhibit different leadership behaviors or styles?

METHODOLOGY: Accomplishment of project objectives has been divided into three activity phases. The first phase of the project will be used to develop an instrument to estimate performance in major work areas of first-line supervisors in general state/federal vocational rehabilitation agencies.

Staff will draft a preliminary measure of successful supervisory behaviors as determined from a comprehensive literature review of supervision in business and industry as well as in rehabilitation. Two advisory task forces will be used to further refine the instrument: current administrators and supervisors from vocational rehabilitation agencies and a small group of experts in the development of psychometric tools who will make suggestions to staff on technical refinements of the instrument.

Staff will then send the instrument to an administrative representative from each of eight state agencies selected by a stratified random sampling procedure based on size and geographic region of states. Representatives will rate the importance of each item to successful supervision within their agency by considering several highly successful supervisors within their agency and then rating the items on a Likert scale.

From agency feedback on item relevance, staff will develop the finalized measure, the Successful Supervision Rating Scale (SSRS). The SSRS will serve two purposes in the critical third phase of the project. It will be used to study the existence of one or more successful "styles" of supervision based upon emphasis of different supervisory activities: planning, organizing, staffing, directing, controlling and representing. Also, the SSRS will be used as an independent measure for determining the relevance of leadership factors or styles to successful supervision.

Phase two will identify one or more widely accepted measures of leadership ability which are applicable to first-line supervision within the state vocational rehabilitation agency.

Project staff will review the leadership literature to identify a small pool of existing measures which seem relevant to rehabilitation. After being presented to an advisory task force of rehabilitation professionals, the most relevant measures will be field tested with a small sample of VR administrators.

They will be asked to use both the SSRS and the leadership measures to rate first the most successful supervisor they have known and then one of the least successful supervisors they have known. Staff will analyze results to evaluate the force validity of the measures.

The final phase of the project will examine whether more successful versus less successful supervisors exhibit different leadership profiles. Twenty four VR agencies representing small, medium and large states as well as each of the geographic regions of the country will participate in this phase.

Twelve supervisors from each state will be randomly selected and asked to participate in the project. They will be rated on the SSRS and leadership measures by an agency administrator, their immediate supervisor, and two of their counselors, as well as by themselves.

The results of the SSRS will be used to define a more successful group and a less successful group of supervisors. This independent measure will be correlated against the leadership ratings to identify any specific leadership behaviors or styles of behavior style that are closely related to supervisory success in the VR agency.

FINDINGS TO DATE: Activities and progress to date have occurred within two major areas: (1) completion of the literature reviews on leadership and rehabilitation supervision; and (2) development of the

preliminary measure of supervisory success.

The literature reviews have turned up several leadership measures to present to a task force for its recommendations of one or more measures for inclusion in the study. The review has also pointed the project more toward a position of analyzing specific leadership **styles** for success in supervision as opposed to leadership **traits**. The "great man" theories of universal leadership characteristics or traits have been all but totally abandoned over the past 10-15 years after many contradictory findings within several studies.

The development of the successful supervision instrument has also been affected by the findings from the literature. Rather than developing a checklist of supervisory characteristics, the SSRS will reflect behaviors exhibited within six functional process areas of supervision: planning, organizing, staffing, directing, controlling and representing.

Much hope is held that this instrument (SSRS) will be of future use to VR agencies, and possibly others, in supervisory self improvement, job evaluation and job training situations. This would be in addition to supervisory selection; uses the leadership measures might potentially serve for agencies.

APPLICABILITY: The critical importance of the first-line supervisor's role to rehabilitation agency processes and outcomes has been well documented over a period of years (Inkster, 1955; Moriarty, 1959; Scurlock, 1959; and Spears & Vialle, 1970). Recent administrative review (HEW, 1975) strongly suggests, however, that there are serious deficiencies prevalent in performance of many first-line rehabilitation counselor supervisors.

This research project holds the potential to provide both the agency and its professional staff with a battery of measures to assist in the identification of the leadership factors and supervisory behaviors which are possessed by successfully functioning first-line supervisors. If such data are obtained that can additionally demonstrate that those supervisors identified as more successful have a substantially different leadership profile or engage in substantially different management activities than those supervisors identified as less successful, this can represent a major step toward providing guidelines to the vocational rehabilitation agency and its personnel in further supervisory selection.

Since there is a substantial amount of dissatisfaction and desire for change in supervisory selection procedures, these projected tools to improve supervisory selection may also contribute to more staff satisfaction/morale. This may prove to be especially true for new staff who are hired to perform as first-line supervisors.

216 The Utilization of Community Services by the Staff and Consumers (Residents) of Group Homes for the Mentally Retarded

Principal Investigators:	Phillip Browning, Ph.D. David Bostwick, Ph.D.	
Status:	New/Continuing	
Dates:	March 1979-February 1980	
Cost:	Annual \$11,248 RT Annual \$11,248	Projected Total \$11,248 RT % of Annual Total 100%
Annual Report Reference:	#14, Page 298, R-54	

OBJECTIVES:

1. To describe what is actually available to community residential facilities, in the way of supportive services for residents;
2. To determine what supportive services are being utilized and how frequently by residents of community residential facilities; and
3. To assess the appropriateness of supportive services currently being utilized by residents of community residential facilities.

METHODOLOGY: The sequential steps used in developing the **Community Services Utilization Questionnaire** were: (1) literature review; (2) interviews with residential facility staff; (3) task force; (4) initial instrument; and (5) field testing and revision. The final questionnaire addressed Health Services, Educational Services, Vocational Services, and General Support Services. Items were generated to include specific services within each of the four domains, frequency and patterns of service usage, and perceptions of service appropriateness.

The project utilized a previously identified nationwide sample of community residential facilities (CRFs). Specifically, that sample consisted of over 5,000 names and addresses nominated by (1) all State Mental Retardation Coordinators; (2) all superintendents of public and private residential institutions; (3) State Developmental Disabilities Councils; (4) State Associations for Retarded Citizens; (5) mental health/mental retardation agencies; (6) regional centers in states where they exist; (7) agencies identified as licensing such facilities; and (8) all individuals or agencies identified by earlier contacts as potential sources of information. These nominators were reduced to a total of 3,582 CRFs after all duplications were removed.

Each of the facilities was surveyed in order to determine if they met the following definition of CRFs which was used for this study:

For the purpose of this project a community residence is a facility for the developmentally disabled which operates 24 hours a day to provide services to a small group of mentally retarded and/or otherwise developmentally disabled persons who are presently or potentially capable of functioning in the community with some degree of independence. These living facilities may also be known as group homes, hostels, boarding houses, and halfway houses. However, this definition does not include foster family placement typically serving five or fewer developmentally disabled individuals. Nor does it include nursing home services or other forms of care which are primarily directed toward meeting the health, health related, and/or medical needs of the resident.

Of the 3,582 facilities, 611 respondents indicated that their facility did fit the definition. The 611 CRFs from this previously identified nationwide sample were updated and added to with the aid of the 1978 National Association of Private Residential Facilities for the Mentally Retarded directory. Thus, the final sample for this study on the utilization of support services included 810 CRFs.

FINDINGS TO DATE: The **Community Services Utilization Questionnaire** was mailed to 810 CRFs throughout the United States. Ninety-one of these questionnaires were returned as undeliverable, while 241 were completed and returned (return rate of 34%). Of these questionnaires returned, however, 112 were completed by facilities not meeting the definition of a CRF adopted for this study, or were inappropriately filled out, and thus were dropped. The remaining 129 questionnaires represent the data pool for this project. These 129 CRFs reportedly serve a total of 1,944 residents. Of 122 facilities reporting the number of residents served by level of mental retardation, 1,344 persons (77%) were classified as mildly or moderately retarded, with 410 (23%) persons described as severely or profoundly retarded. An in-depth analysis is currently being conducted regarding the nature of supportive services which are available to these CRFs.

APPLICABILITY: Large numbers of retarded persons have been returned to the community from institutions in recent years. In order to maximize the successful transfer of these individuals to community-based residential facilities and to insure their adjustment to community life, support services must be found within the community itself. Results of this project will provide habilitation personnel with a more complete view of community-based support services available for use by retarded persons. Further, as habilitation specialists begin to deal more consistently and appropriately with this area, information from studies such as this will prove helpful in identifying new resident training programs.

217 The Mentally Retarded and Consumerism within the Rehabilitation System: A State-of-the-Art Study

Principal Investigators: Phillip Browning, Ph.D.
Cindy Rhoades, Ph.D.

Status: New/Continuing

Dates: March 1979-August 1980

Cost: Annual \$63,670
RT Annual \$63,670
Projected Total \$125,000
RT % of Annual Total 100%

Annual Report Reference: #14, Page 320, R-55

OBJECTIVES: The purpose of this study is to produce a state-of-the-art document on consumerism and the vocational rehabilitation process with primary attention directed to the mentally retarded clients. This goal will be accomplished by addressing the following specific objectives:

1. To conduct an "historical" study on consumerism and rehabilitation via content analysis on the following documents: congressional records related to rehabilitation, federal rehabilitation legislation since 1973, and administrative regulations and guidelines pertaining to that legislation;
2. To conduct a comprehensive literature and analysis on handicapped consumerism in rehabilitation;
3. To conduct a content analysis on Client Assistance Project program documents and to survey personnel of these projects via questionnaire in order to ascertain their experiences and perceptions in serving mentally retarded clients in vocational rehabilitation;
4. To conduct a survey of rehabilitation service providers via questionnaire and personal interview in order to ascertain their experiences and perceptions in serving mentally retarded clients in vocational rehabilitation; and
5. To conduct a study of mentally retarded clients via in-depth interviews in order to ascertain their experiences and perceptions in receiving rehabilitation services.

METHODOLOGY: In order to obtain a comprehensive understanding of the state-of-the-art of mentally retarded clients' involvement in consumerism, data will be derived from five major sources: (1) congressional records, federal legislation, and regulations; (2) literature; (3) Client Assistance Projects; (4) rehabilitation service providers; and (5) mentally retarded rehabilitation consumers or their representatives. Each of these areas is addressed below.

Congressional records, federal legislation, and regulations. Objective One proposes to determine the state-of-the-art of consumerism in rehabilitation relative to federal rehabilitation legislation, congressional intent of this legislation, and the regulations promulgated to implement the legislation. That is, components of these three sources of information which have implications for consumerism in the rehabilitation process will be analyzed in order to ascertain (1) the purposes, methods, and expected outcomes of consumer involvement as envisioned by Congress; (2) the specific ways in which these purposes, methods, and expected outcomes were translated into legislation; and (3) the degree to which the implementation regulations adequately address the legislative mandates and congressional intent.

Literature. Objective Two is to conduct a comprehensive literature review, particularly with respect to research conducted in the area of consumerism within the rehabilitation system. The compilation of existing research done in this area will provide a necessary "backdrop" for identifying problems in the overall consumer movement which are in need of investigation.

Client Assistance Projects. The third objective is to gather and analyze information from Client Assistance Project personnel in regard to their perceptions of consumerism as practiced by mentally retarded persons. Client Assistance Projects were first established under the Rehabilitation Act of 1973 for the purpose of helping rehabilitation clients and potential clients to be aware of their rights and to relate effectively to the rehabilitation system. The authorization of these Projects may be viewed as a congressional response to the consumerism movement. Given the purpose of the Client Assistance Projects and the support for them, they appear to be a valuable source of data on consumerism.

The experiences and perceptions of Client Assistance Projects as they relate to consumerism and the mentally retarded will be examined in two ways: records and documents which report on the Projects' experiences will be analyzed, and a questionnaire will be developed for the purpose of specifically tapping the knowledge, expertise, and perceptions of Client Assistance Project personnel in regard to consumerism with mentally retarded clients.

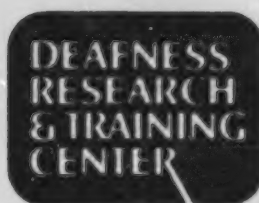
Rehabilitation service providers. Implementation of this objective will be accomplished through a survey of rehabilitation counselors to determine their perceptions of retarded clients' involvement with consumerism. Counselors who participate in this nationwide study will carry caseloads which are comprised of a minimum of 33% mentally retarded clients. A second research strategy will be to personally interview a limited number of the rehabilitation counselors selected from the first sample. An open-ended, in-depth interview guide will be used to tap the meaning and affect of the consumer movement on counselors and their clients.

Mentally retarded clients. This objective will be accomplished through open-ended, in-depth interviews with mentally retarded clients to ascertain their understanding of and involvement with consumerism. Subjects will be randomly selected from the caseloads of the limited sample of rehabilitation counselors who will also be personally interviewed.

FINDINGS TO DATE: The study is still in the initial stages of investigation and no findings or conclusions can be drawn.

APPLICABILITY: Findings from this state-of-the-art study will be primarily used as the basis for designing and proposing a large-scale research project on consumerism as it relates to mentally retarded persons. Also, the baseline knowledge acquired may be utilized in a training capacity for practitioners who are currently dealing with clients as active consumers involved in determining the content and process of service provision.

Such baseline knowledge will enhance our understanding of the effectiveness and appropriateness of consumerism as it relates to mentally retarded clients. This information has definite implications for pinpointing unforeseen problems in consumer involvement. It also indicates the actual changes which occur in policy and program changes from the congressional level to the practical implementation of regulations at the service level.



**New York University (RT-17)
Deafness Rehabilitation Research and Training Center**

CORE PROBLEM

Improving the Delivery of Services to Deaf People

CORE AREAS

Developing Models for Service Delivery

Determining the systems which most effectively and efficiently deliver services to deaf people.

Developing the Data Base

Gaining accurate information on the demographic characteristics of the deaf population, necessary for effective planning and delivery of social and rehabilitation services.

Communication Research

Proximal (face-to-face) communication and telecommunication (communication at a distance) with deaf persons.

Vocational Research and Development

Examination and development of work evaluation practices with deaf persons; examination of specific occupational factors which militate against the employment and promotion of deaf workers.

Deaf Community Development

Research and training projects designed to bring deaf consumers into more active and constructive roles in planning and delivery of services to the deaf community.

Personnel Research and Development

Examination of techniques to expand the reach of existing professionals to greater numbers of deaf clients and to facilitate the preparation of new personnel.

NEW YORK UNIVERSITY DEAFNESS CENTER

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COMPLETED

ABSTRACT NO.

Development of Videotapes for Application in Training Rehabilitation Counselors to Work with Deaf Clients (T. Freebairn, Ed.M.)	218
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CONTINUING

Tailoring Captions for Deaf Audiences (A.L. Stewart, Ph.D.)	222
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TERMINATED

Telecommunications for Deaf People: Developing the State-of-the-Art Report

PROPOSED

Visual Information Processing

218 Development of Videotapes for Application in Training Rehabilitation Counselors to Work with Deaf Clients

Principal Investigator:	Thomas Freebairn, Ed.M.	
Status:	Completed	
Dates:	September: 1974-December 1977	
Cost:	Annual \$16,825 RT Annual \$14,605	Projected Total \$50,000 RT % of Annual Total 87%
Annual Report Reference:	#12, Page 32, R-29	

OBJECTIVES: To design, produce, and evaluate a series of pilot videotapes of counseling sessions with deaf clients for use in programs which train counselors to work with deaf people.

METHODOLOGY:

1. Variables to be considered as important in the videotapes include interview content (type of problem experienced by client), counselor fluency in the use of manual communication, and level of the client's use of language.
2. Representative counseling interview involving selected examples of client problems, characteristics, and related counselor-client interaction will be simulated on videotape. Due to the possible infringement upon client confidentiality which could occur with videotaping of "live" counseling interviews, professional deaf actors and actresses, or Deafness Center staff will simulate clients.
3. Following development of the script, rehearsals, and editing, a pilot videotape was made using the staff and facilities of the Deafness Center. It was expected that this approach would permit maximum refinement of the script prior to contracting with a professional studio to make final videotapes in a subsequent future project if funds become available.
4. Following this preliminary evaluation, refinements were made of basic components. Script outlines were prepared for the entire series. The full series was then produced, edited and evaluated.

The video-tape series was based on an adaptation of the Interpersonal Process Recall approach developed by Dr. N. Kagan.

In evaluation, special attention was given to the following components: stimulus films, counselor-client simulations, interpersonal process recall sessions.

FINDINGS TO DATE: Preliminary scripts and introductions have been developed for six proposed videotapes. One 30-minute pilot tape using Deafness Center staff and facilities has been completed. Portions of these materials have been reviewed by the Deafness Center Advisory Board, by students in Deafness Center training programs and by other Deafness Center staff members. The evaluations have all been very enthusiastic, in each case including strong recommendations to develop the materials further and to explore arrangements for producing and distributing them for use by other counselor training programs around the country.

A video-tape series of the six initial tapes was produced and evaluated. The major components of the series, based on an adaptation of Kagan's Interpersonal Process Recall (IPR) method of counselor training, were evaluated. It was found that adaptation of the IPR method for training with deaf clients is necessary, especially with respect to demands on camera technique (to include both sign language and the facial expressions of client and counselor, for example), and that special attention must be paid to the nonverbal communication of a sign language interpreter and of the counselor. Further evidence was found by which specific production and training modifications should be guided.

Tapes were rated positively as to clarity, readability, content, personal reactions, and motivation. While speech-reading was difficult, sign language was clear. Tapes are available at cost. Literal captions will be provided pending further funding of the project.

Copies of the television tapes are available on request. Fee will be determined by reproduction costs at the time of the request.

APPLICABILITY: Rehabilitation counselors are the coordinators of rehabilitation services. Consequently, their ability to communicate with and provide effective counseling to deaf clients is a critical aspect of the total rehabilitation program.

The tape and materials are expected to prove especially useful in orientation-to-deafness seminars for rehabilitation counselors, and in classroom work of students in rehabilitation counseling programs at NYU. This application will provide effective field evaluation of the materials. A future project, if funded, would produce the final materials in suitable form (videotape or film) and make the master copies available for duplication and distribution to other training programs.

Copies of the completed series of video-tapes are available on an at-cost basis in order to reach counselor training programs, graduates and undergraduates in the fields of deafness and/or rehabilitation. At-cost copies are available also to all state vocational rehabilitation agencies, and Rehabilitation Continuing Education Programs in order to reach ongoing inservice training activities.

It is anticipated that the series of video-tapes will help to fill the urgent need of counselors and counselor trainees for visual materials regarding counseling with deaf clients. If the series is used properly, we expect that the students will make substantial improvements in their counseling techniques with deaf clients. We also anticipate that the final plan for utilizing the tapes within training programs will serve as a model for later introduction of other media and materials.

219 Career Development for Deaf People: Nonoral Communication Specialist

Principal Investigator:	Jerome D. Schein, Ph.D.	
Status:	Completed	
Dates:	June 1976-August 1978	
Cost:	Annual \$63,130 RT Annual \$48,725	Projected Total \$132,000 RT % of Annual Total 77%
Annual Report Reference:	#12, Page, 44, R-49	

OBJECTIVES: To evaluate the adequacy of preparation for Nonoral Communication Specialists (NCS), whose services will aid clients who, like most prevocationally deaf people, may have adequate verbal skills but poor control of the vocal mechanism, with the result that their poor communication skills hinder their employment.

To evaluate the effectiveness of Nonoral Communication Specialists in working with various disability groups: e.g., mentally retarded, autistic, aphasic, schizophrenic.

To determine the extent of the job market for Nonoral Communication Specialists.

To investigate potential barriers to employment of Nonoral Communication Specialists and develop appropriate countermeasures.

METHODOLOGY:

1. NCS applicants were selected from among prevocationally deaf persons who were between the ages of 18 and 50 years; had at least a high school equivalency but not a college degree; were under- or unemployed; showed adequate manual communication skills, interest, and motivation.
2. A sample of five institutional settings, including a hospital, developmental center, and public school was selected for the practicum part of the training.
3. The NCS training program begins with an introduction to the disability groups trainees may encounter: autism, aphasia, schizophrenia, cerebral palsy, and mental retardation. Consideration of each diagnostic category is divided into discussion (60), reading (10), and observation (30). The ethical principles and interprofessional relations an NCS must learn are strongly emphasized pre-practicum and during the practicum. Techniques of manual communication are thoroughly reviewed. Principles of instruction are discussed and practiced in the classroom. On completion of the didactic portion of the program, trainees enter a carefully supervised four-month practicum.

During the first year of the program, trainees rotated through various settings. At the request of trainees and practicum administrators, however, this arrangement was modified for the second year to one setting per trainee for the full four months, so as to enable more time for training after establishing rapport, learning the facility's routine, and becoming acquainted with persons to be served.

4. Data from the following sources were analyzed: trainees' application forms, providing basic demographic and attitudinal data; trainee logs of practicum experiences; periodic interviews of institutional supervisors; supervisors' individual trainee and general program evaluations made at the end of the training period; the coordinators' ongoing individual trainee records.

FINDINGS TO DATE: The following conclusions serve to summarize the detailed findings upon which they are based.

1. The NCS concept is viable. Deaf people can, with proper training, fill a useful role in treatment of aphasic patients, autistic children, some cerebral palsied persons, and mentally retarded persons.
2. The job potential in this field exists for deaf persons.
3. Length of training should be increased. Probably an Associate of Arts (A.A.) degree should be developed. Content to be increased relates to specific disabilities and to methods and materials of instruction. Practicum assignments should be 204 months per setting.
4. NCS trainees need heavy emphasis on how to cope with such bureaucratic structures as tend to be in hospitals.
5. Current budgetary constraints on most health-care and educational facilities will prevent rapid addition of NCS personnel. Hence, substantial lead time should be sought before assigning trainees to practicum sites. With sufficient time to secure funds, three of the institutions in this study indicated they would hire one or more of the trainees assigned to them.
6. The fact that manual communication is effective with the afflicted individuals served by the NCS trainees in this study is consistent with findings reported with increasing frequency. However, the ability of deaf persons to provide the manual communication to these **nondeaf** disabled persons has not previously been demonstrated—nor has it apparently been considered. That the deaf NCS can successfully teach manual communication to aphasic, autistic, mentally retarded and cerebral palsied persons has been demonstrated.

A manuscript detailing these findings has been submitted for publication. Preprints are available from the Deafness Research and Training Center, New York University.

APPLICABILITY: This project has value in opening a career for deaf people in the helping professions—an area in which they have been sparsely represented. The resulting jobs should increase the number and quality of rehabilitations.

Secondly, the project has some paradigmatic value. It illustrates an approach to job development which may be successfully applied to further activities on behalf of deaf clients and to other disability groups. For vocational rehabilitation, service delivery culminates in appropriate job placement. Too often, deaf clients have been assigned jobs below their vocational potential. This project aims to turn a formerly disabling characteristic into an occupational asset: to find profitable uses for manual communication. By means of this example, other projects may be stimulated which will improve the occupational status of deaf citizens.

220 Economic Status of Deaf Adults

Principal Investigator:	Jerome D. Schein, Ph.D.	
Status:	Completed	
Dates:	September 1976-August 1978	
Cost:	Annual \$80,580	Projected Total \$125,000
	RT Annual \$58,650	RT % of Annual Total 73%
Annual Report Reference:	#12, Page 58, R-50	

OBJECTIVES: This study proposes to follow-up early 1977 the 1972 National Census of the Deaf Population (NCDP) sample to assess their experiences with the ongoing economic recession.

The primary purpose of the Economic Conditions Survey is to collect up-to-date facts about the number of deaf persons in the country who are employed, unemployed, or not in the market for jobs.

A further aim is to provide information as to the characteristics of greatest importance in dealing with the unemployed—their sex, race, age, how long they have been looking for work and what their last jobs were, the kind of work deaf people are doing and how many hours they work (essential for judging the economic condition of the deaf community), and the personal and family income of deaf adults as well as the sources of such income.

METHODOLOGY: The target population was defined, in the 1972 study, as those persons who cannot hear and understand speech when spoken directly into their ear, such impairment having been suffered prior to 19 years of age. This group is referred to here as the prevocationally deaf population.

A panel technique was employed to study changes over time with respect to the 1972 study. The sample included individuals involved in the earlier study and was obtained by means of a multi-stage cluster sampling technique with stratification.

Questionnaire design was based on the self-administered format. Categories of information tapped included demographic characteristics, hearing ability, occupation and work experience, income, education, experience with department of vocational rehabilitation, and geographic mobility. The procedure included pretesting of the questionnaire and an interview follow-up in order to pilot survey procedures, follow-up of nonrespondents, and descriptive and analytic data analysis.

FINDINGS TO DATE: Findings support the general conclusion that deaf adults have suffered disproportionately from economic conditions over the past half dozen years. Employment is down; relative earnings have dropped. The economic status of the deaf population has greatly deteriorated.

Detailed findings included the following:

1. A higher proportion of deaf workers was not in the civilian labor force during 1977, as compared with the proportion of deaf workers out of the civilian labor force during 1971.
2. With some qualifications, a higher proportion of deaf workers was unemployed during 1977 than 1972; a lesser proportion of deaf workers was employed during 1977 than 1972.
3. The proportion of deaf males residing in or heading a household with government-supported family income was higher in 1976 than in 1971.
4. Personal income of deaf workers has declined from 1971 to 1976, relative to the general population.
5. The difference in family income between workers in the general population and deaf workers has increased from 1971 to 1976.

It is estimated, moreover, that the extent of the economic decline is even greater than survey results would indicate, due to an upward bias in the socioeconomic characteristics of those who responded. The present respondents, though generally representative of the deaf population, tended to be educationally and occupationally better off.

A manuscript detailing these findings has been submitted for publication. Preprints are available from the Deafness Research and Training Center, New York University.

APPLICABILITY: Results are expected to provide a solid base for VR agency administrators to use in designing and modifying state plans for rehabilitation of deaf clients. Project results will be especially useful to policy makers in rehabilitation at the federal, regional and state levels. Federal and state administrators will want to know the specific implications of this project upon delivery of services to deaf clients under their jurisdiction. Probably of immediate concern in this regard is: (1) the displaced deaf worker; (2) the direction which training for deaf clients should take; (3) the deaf worker during a time of national economic crisis; and (4) how state VR agencies can plan for anticipated deaf caseloads.

The results may be useful to professionals working with other disability groups.

Deaf consumers and their leaders as well as other handicapped consumers can use project findings for advocacy purposes.

221 Fatigue in Visual Communication

Principal Investigator:	Alan L. Stewart, Ph.D.	
Status:	Completed	
Dates:	September 1976-August 1978	
Cost:	Annual \$49,300 RT Annual \$37,500	Projected Total RT % of Annual Total 76%
Annual Report Reference:	#12, Page 112, R-63	

OBJECTIVES: The studies currently undertaken are concerned with understanding how visual information is processed and discovering how deaf observers can most effectively use all of the visual information available to them. Research is directed at the discovery of principles which facilitate designing efficient displays of visual information, and may in turn help us understand how deaf viewers can best be trained to analyze and extract the information available within their visual environment.

METHODOLOGY: Our research strategy entails two complementary approaches. We have been combining a mathematical approach with the principles of systems analysis in order to devise a model by which we can calculate the interference effects due to the interaction of the set of design, we expect that the mathematical model which we are developing will tell us how the psychophysical product will vary as a function of the interaction of the complex set of elements in the physical display and the visual and cognitive characteristics of the observer. At the same time, we are employing an empirical approach which involves the systematic investigation of the perception of visual displays, the physical parameters of which have been varied in accordance with standard psychophysical procedures. The second approach is complementary to the first in that we are seeking to test the validity of our mathematical model at each stage of its development.

The concept of a transducer function has been shown to be useful in engineering studies of television as well as to other display devices. It has also been shown that the best transmission system for displays of static material are those whose transfer functions most closely match that of the human visual system. In order to understand how the human observer handles visual information that varies over time, as it does with fingerspelling or television captions, however, these concepts must be generalized to both spatial and temporal dimensions.

FINDINGS TO DATE: Reducing the overall level of illumination to some moderate level improves visual performance. But reducing the target energy, by itself, is not an effective means of eliminating all visual interference, since forward interference effects become more pronounced than backward effects as the level of illumination is lowered. Therefore, determining the optimal tradeoff in the absolute level of illumination of dynamic stimuli which will minimize forward and backward interference effects must await a detailed and well-developed model of visual information processing.

Results are detailed in two published articles:

1. Laterally induced impedance effects in vision. *Journal of Mathematical Psychology*, 1978, 13, 73-99.
2. The mathematical theory of lateral impedance of visual activity and an application of Markov processes. *Biological Cybernetics*, 1978, 30, 99-108.

APPLICABILITY: Final results of this research will be of use to a broad range of people. They will be of use to decision makers, who must determine how instructional materials are to be delivered to deaf people—via television, film, or through text books. They will be particularly useful in deciding if instructional material on television or films should be captioned with literal, written captions or by means of manual communication, because the answer depends, in part, on how well television transmits the critical elements of such dynamic visual displays. They will also have much to con-

tribute to decisions on the rate at which information can be delivered optimally via films and television as well as in interpersonal instructional settings. The results should also prove to be useful in systematic and programmatic investigations of the traits and abilities which underlie successful lip reading and manual communication.

222 Tailoring Captions for Deaf Audiences

Principal Investigator:	Alan L. Stewart, Ph.D.	
Status:	Continuing	
Dates:	September 1976-October 1980	
Cost:	Annual \$26,500 RT Annual \$20,900	Projected Total RT % of Annual Total 79%
Annual Report Reference:	#12, Page 95, R-52	

OBJECTIVES: This project's immediate objectives are, first, to validate the existence of consistent differences among deaf viewers in the way in which they process fingerspelled and printed captions; and, second, to find additional correlates of differences in performance on these two tasks such as to maximize prediction of the fit of each captioning technique to a variety of target audiences. These efforts represent part of our commitment to the ultimate goal of specifying well-formulated guidelines by which each captioning technique can best be adapted to meet the cognitive needs of groups of deaf viewers whose characteristic modes of processing linguistic input differ. Only in this way can the instructional and rehabilitative benefits of captioned material be extended to all members of the deaf community.

METHODOLOGY: Conrad (British Journal of Psychology, 1972) has documented some evidence of differences among deaf children in their cognitive styles, in that some deaf children confuse letter sequences which sound alike, while other deaf children do not; rather, the children in the latter category confuse sequences of letters which look alike. Attributing a characteristic cognitive strategy to a particular deaf child implies that there should be some generality of coding preferences, within this same individual, across the different types of linguistic material available to him. While this assumption has been implicit in studies reported by Conrad, for example, it has not been studied directly.

Results of our previous experimentation indicate that deaf viewers may differ in the way in which they habitually process and store visually presented information. Some deaf viewers seemed to process both strings of fingerspelled letters and pairs of printed letters by means of a quasi-auditory or phonic code, while other deaf viewers seemed to emphasize visual codes. If it can be shown that there are stable differences among deaf viewers in their emphasis on one of two styles of processing visually presented cognitive material, then instructional material in general and, more particularly, captioned instructional material, can be optimized for each of these two kinds of visual processors.

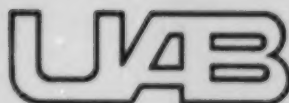
More specifically, in the studies being conducted, variations in reaction time (RT) to matching pairs of visually presented letters are measured as a reflection of differences in the coding strategies employed. In this task, first investigated extensively by M. Posner, subjects identify two letters as being the same when they are physically identical, as in the letters AA, or when they are of different case but nominally the same, as in Aa. In the seminal study by Posner, the occurrence with hearing subjects of faster RT's to physical than to name matches suggested that coding strategies might have differed according to the kind of similarity between the two letters within a pair. It was reasoned that, while for the same-case letter pair (a **physical match**) a visual coding strategy was possible, the mixed-case pair (or **name match**) required some other, perhaps verbal, type of code in order for the two visually dissimilar stimuli to be identified as representing the same letter. Hence, performance on Posner-like tasks are now being related to the performance of deaf people on recall of fingerspelled letters.

FINDINGS TO DATE: Subjects may in fact differ in the coding strategy which they emphasize in the Posner task, some subjects tending to code both physical and name matches verbally, others using verbal codes only for name matches. Differences among deaf subjects were found in their per-

formance on both the Posner task and in their recall of sequentially presented fingerspelled letters. Deaf subjects whose report of sequences of fingerspelled letters produced bow-shaped serial position curves, of the type typically found among hearing subjects with auditory short term memory, had longer RT's to both types of matches on the Posner task, with a comparatively small difference in time to the two types of matches. Other subjects showed monotone decreasing serial position curves, more common with visual short-term memory, on the fingerspelling task, and larger elevations in RT to name matches.

Most recently, results have validated and extended our earlier studies, first by replicating our previous findings with an enlarged sample. A discriminant analysis indicated that subjects grouped according to their patterns of recall for the fingerspelled items also showed systematic patterns of differences in the speed with which they performed physical and name matches. The pattern of differences in performance on the two tasks, observed in our earlier studies, was replicated. An objective classification rule, developed from earlier research, produced two groups showing the hypothesized differences.

APPLICABILITY: Many deaf rehabilitation clients do not develop a full linguistic competence of which they are capable. Performance of the same linguistic task may require a different hierarchy of skill development for people who differ in means of visually processing linguistic information. Instructional approaches and the visual supplements which are employed can truly serve their functions only when we have the knowledge necessary to adapt both technique and material to the characteristics of the individual.



**University of Alabama in Birmingham (RT-19)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Spinal Cord Injury

Projects to impact upon the specific course of care as well as influence eventual rehabilitation outcomes of victims of this catastrophic condition. Studies address therapeutic agents, various treatment modalities and basic research questions—each intended to fill voids in knowledge gaps so as to improve the rehabilitation outlook and potential for the spinal cord injured patient. Activities are designed to provide the professional and scientific community with data and findings applicable to medical and vocational programs.

**Metabolic Effects of Severe Disability in Both Static
and Dynamic Conditions**

Activities addressing physical disability globally, by measuring, assessing and evaluating the disability component of a broad spectrum of conditions and/or diseases.

**Assessment of Long-Term Needs of the
Severely Physically Handicapped**

Activities designed to lead toward the development of definitive information essential to the development of strategies to prevent the occurrence of costly interruptions to successful rehabilitation and to provide necessary services which will be readily available throughout the patient's entire lifetime.

Biocommunications

Continuing research designed to create and disseminate a vast new body of knowledge relative to the process of oral communication resulting in a continual increase in the understanding of the physiologic and anatomic basis of problems—leading to the development of corrective therapeutic modalities. Knowledge and skills growing out of this work will markedly improve the patient/client's ability to participate successfully in a vocational rehabilitation program.

UNIVERSITY OF ALABAMA IN BIRMINGHAM

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COMPLETED

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University of Alabama in Birmingham

NEW

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Didronel in the Prevention of Heterotopic Ossification Following Spinal Cord Injury—Determination of an Optimal Treatment Schedule	
A Voice Operated Response Unit (VORU) to be used in the Psychological Assessment of Motor Impaired Subjects	
Prescriptive Arm Ergometry to Optimize Muscular Endurance in Spinal Cord Injury Patients	
Assessing the Need for Post-Discharge Psycho-Discharge Psycho-Social Services for the Spinal Cord Injury Patient	
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223 Energy Expenditures While Performing Normal Street Walking—A Comprehensive Study Using MAMA and Involving Paraplegics, Stroke Patients and Amputees, as well as Normal Subjects, and a Variety of Assistive Devices

Principal Investigator: Chi-Tsou Huang, M.D.
Status: New
Status: Completed
Dates: January 1975-June 1978
Cost: Not applicable
Annual Report Reference: #13, Page 345, R-53

OBJECTIVES

1. To compare energy expenditure during repeated tests of "MAMA-Walking" and treadmill walking.
2. To compare energy expenditure during ambulation by normal subjects, below-the-knee (BK) amputee subjects and above-the-knee (AK) subjects.
3. To compare energy expended by two subjects using different types of lower limb prostheses during ambulation.
4. To compare energy expenditure during ambulation by normal subjects and paraplegics using Craig-Scott braces.
5. To compare energy expenditure requirements of patients (a) during several types of patient transfers and (b) in commonly prescribed hospital bed positions, e.g., Supine, Sitting, Semi-Fowler, etc.
6. To compare energy expenditure of quadriplegics in the sitting position and in the following tilt-table positions: 20° head-down, supine and 30° head-up.

METHODOLOGY: A mobile automatic metabolic analyzer (MAMA) mounted on a motorized cart with an automatic speed control, capable of following a predetermined path is used to measure certain physiologic parameters during activity. Simultaneous measurements of %O₂, %CO₂, %N₂, %H₂O as well as inspired and expired volumes are acquired. Using gas fractions, volume data and the mathematical technique of indirect calorimetry, true minute oxygen consumption is calculated. All data are reduced to STPD conditions. Energy cost of ambulation calculated from O₂ consumption is then expressed as a function of time, distance or unit weight and body surface area of the subject. All data processing and computation is performed on a PDP 11/40 digital computer.

FINDINGS TO DATE: Previously unsuspected, as well as suspected differences in energy expenditure requirements have been identified in a number of substudies. These results include: (a) Oxygen consumption at subject-specific comfortable walking rates was 9% higher in unilateral BK amputees, 48.7% higher in unilateral AK amputees and 280% higher in bilateral AK amputees when compared with an unimpaired group; (b) statistically significant differences in energy consumption have been observed in subjects using artificial prostheses of varying designs; (c) energy expenditure among subjects engaged in common hospitalized patient positions was significantly affected by both position and time within position. The lowest mean energy expenditure was in the semi-fowler #1-B position, with the highest mean energy expenditure occurring in the semi-fowler #2-A position. This energy expenditure reflects the move from wheelchair to bed.

A more detailed analysis of the findings of this research project may be found in the following articles:

1. Petersen, J.D., Traugh, G.H., Jackson, J.R. and Wood, T.B. MAMA - A System to Evaluate Orthoses and Prostheses During Actual Ambulation and Exercise on the Basis of Energy Expenditure. **Proceedings, San Diego Biomedical Symposium**, 14, 441-450, 1975.

2. Huang, C.T., Jackson, J.R., Moore, N.B., Fine, P.R., Kuhlmeier, K.V., Traugh, G.H. and Saunders, P.T. Energy Cost of Ambulation for Amputee Patients: A Study Using the Mobile and Automatic Metabolic Analyzer. *Arch. Phys. Med. Rehabil.*, 60, 18-24, 1979.
3. Huang, C.T., Kuhlmeier, K.V., Moore, N.B., and Fine, P.R. Energy Cost of Ambulation Using Craig-Scott Braces Among Paraplegics: A Study Utilizing the Mobile Automatic Metabolic Analyzer (MAMA) *Arch. Phys. Med. Rehabil.* In Press.
4. Jackson, B.S. and Kinney, M.R. Energy Expenditure, Heart Rate, Rhythm and Blood Pressure in Normal Female Subjects Engaged in Common Hospitalized Patient Positions and Modes of Patient Transfer. *Int. J. Nurs. Stud.*, 15, 115-128, 1978.
5. Kinney, M.R. and Jackson, B.S. Exploratory Nursing Research for Prescribing Patient Care. *Heart & Lung*, 7, 295-298, 1978.

APPLICABILITY: Results in findings from these and future studies may be utilized in the selection of prostheses and orthoses as well as in the design of new devices. It is anticipated that a direct clinical application will soon be achieved. Findings from nursing substudies will have direct and immediate clinical application since objective data will be available to direct certain nursing practices regarding patient positioning and transfer modes.

Many conventional braces and prosthetic devices are often prescribed in an arbitrary manner. For this reason large amounts of VRS funding is frequently dissipated into devices which are not commonly used by the client/recipient. MAMA provides a quantitative way to assess the true efficiency related to weight and other mechanical factors of these devices and ultimately will result in tremendous savings when inefficient devices are no longer prescribed.

224 Overcoming Disincentives to the Rehabilitation of SSI and SSDI Beneficiaries

Principal Investigator: Sybil R. Better, M.S.
Status: Completed
Dates: June 1976-June 1979
Cost: Not applicable
Annual Report Reference: #13, Page 465, R-55

OBJECTIVES:

1. To identify, define, examine and document the universe of apparent and obscure disincentives which may be operating among social security beneficiaries as deterrents to the vocational rehabilitation process;
2. To construct a retrospective profile of SSI/SSDI beneficiaries who successfully complete or do not complete a vocational rehabilitation program;
3. To examine the interactive role of apparent, obscure and documented disincentives in the eventual outcome and vocational rehabilitation process among SSI/SSDI beneficiaries;
4. To determine the feasibility of constructing a model capable of simulating vocational rehabilitation outcome responses for selected disincentives;
5. To develop experimental intervention strategies intended to enhance probability of successful completion of a vocational rehabilitation program;
6. To provide descriptive statements supported by objective data which address numerous questions about SSI/SSDI beneficiaries involved in vocational rehabilitation programs who may confront or may be confronted by universal apparent and/or obscure disincentives, each subject to the influence of unique personal characteristics.

METHODOLOGY: Data on disincentives to vocational rehabilitation were collected in a two-phase project. During phase I, RSA 300 data from a national sample (n=65,155) were analyzed to obtain descriptive profiles of demographic and other characteristics which distinguish between SSI and/or SSDI beneficiaries who completed, as opposed to those who did not complete, a

vocational rehabilitation program. During Phase II of the project successfully and unsuccessfully rehabilitated clients and rehabilitation counselors were questioned, utilizing a structured interview schedule, about their perceptions of disincentives to vocational rehabilitation. Analyses of the data in conjunction with demographic and other biographic information on both groups of respondents will submit the examination of intergroup differences in perceptions of deterrents to vocational rehabilitation.

FINDINGS TO DATE: Vocational Rehabilitation Clients receiving Social Security Disability Insurance and Supplemental Security Income are rehabilitated at a lower rate than non-beneficiaries or severely disabled clients in general. Furthermore, rehabilitated beneficiaries are underrepresented among clients who were self-employed or working in the competitive labor market at the time of case closure; instead, beneficiaries are disproportionately employed in sheltered settings and in the home (i.e., homemakers, unpaid family workers). These findings suggest that severity of disability accounts, at least in part, for problems in rehabilitating beneficiaries. However, it also appears reasonable to conclude that disability-related benefits discourage some disabled individuals from returning to the labor force.

Profiles of rehabilitated and nonrehabilitated clients were developed for the total client sample as well as the beneficiary subset. Only three Entry variables were found to distinguish between clients of differing rehabilitation outcomes in both samples: (1) major disabling condition, (2) work status at entry into the program, and (3) source of referral to VR. Status 26 closures were more frequent among clients whose major disabilities were visual or hearing impairments, amputations, digestive disorders and genito-urinary conditions (excluding End-Stage-Renal Disease). Similarly, clients reporting any vocational or vocationally related activity (i.e., labor force participant, homemaker, unpaid family worker or student) at program entry were disproportionately likely to be rehabilitated. In addition, referrals by educational institutions, private organizations, and self-referrals resulted in above average rates of rehabilitation. Rehabilitation process variables (time in rehabilitation, types and costs of services provided) were generally poor predictors of closure status, the exceptions being: (1) number of services received by clients, and (2) agency provision of restoration services and adjustment training.

For both the Total and Beneficiary Samples, a majority of nonrehabilitated closures were attributed to breakdowns in agency-client relationships. However, while an inability to contact a client was the predominant reason cited in case closures in the total client sample, severity of handicap was the major factor accounting for nonrehabilitated outcomes among beneficiaries.

The results of a comparison of Vocational Rehabilitation Clients who are recipients of SSI and SSDI benefits with their non-beneficiary counterparts are also presented. A brief review of these results reveals that at entry into the program, beneficiaries differed from non-beneficiaries on a large number of variables including age, family size, major disabling condition, work status, and source of referral to VR. However, their rehabilitation programs were quite similar in terms of expenditures, months in various statuses and services provided. Nevertheless, and as previously noted, the probability of being rehabilitated was lower for beneficiaries.

The Vocational Rehabilitation counselors, who were interviewed during Phase II, stressed the importance of work attitudes as a determinant of rehabilitation outcome. The counselors strongly favored changes in the linkage between cash disability benefits and government health insurance, and were particularly enthusiastic about allowing employed beneficiaries to retain their Medicare coverage. Also, increasing the substantial gainful activity level so clients could earn as much as \$500 per month before benefits were withdrawn received substantial support from the counselors.

APPLICABILITY: The Vocational Rehabilitation Act of 1973 establishes a primary goal of the State/Federal Rehabilitation Program as the "return of disabled persons, when possible, to substantial gainful activity." It is known many severely disabled persons often find it necessary to apply for and receive SSDI and/or SSI benefits during the course of rehabilitation. Under present Social Security law, a recipient who subsequently becomes rehabilitated and ready for employment finds himself in the rather awkward situation of being unable to afford to return to work. Knowledge of the characteristics of clients who are not rehabilitated and disincentives to their rehabilitation is necessary if modification to delivery of rehabilitation services and the milieu in which they are provided is to be successful.

225 Long-Term Follow-Up Studies of Patients with Spinal Cord Injury Who Become Catheter-Free Following an Intermittent Catheterization Program

Principal Investigator: Samuel Stover, M.D.
Status: Completed
Dates: June 1976-June 1979
Cost: Not applicable
Annual Report Reference: #13, Page 127, R-57

OBJECTIVES

1. To evaluate long-term renal status and complications among patients who have successfully completed the intermittent catheterization program (ICP).
2. To compare long-term renal status and medical complication findings on catheter-free patients with similar findings from those of patients who never become catheter-free and continue with an indwelling catheter.
3. To evaluate chronic bladder changes on follow-up examination and effects of such changes on upper urinary tract deterioration.
4. To re-evaluate previous literature which suggests ICP followed by a catheter-free state is the ideal method of long-term urinary tract drainage.

METHODOLOGY: An ICP has been in progress for 6 years. All male spinal cord injury patients enter the program unless entry is precluded by specific contraindication. All patients are followed on a long-term basis and studied for morphologic and functional changes in kidneys, ureters and bladder. The protocol utilized pyelocaliectasis as the determinant of upper tract (renal) abnormality. Caliectasis must be present to be considered abnormal. Dilatation of the renal pelvis or ureter without caliectasis is not reported as abnormal. Degrees of pyelocaliectasis are graded according to predetermined parameters.

FINDINGS TO DATE: One hundred seventy-one (171) SCI patients whose acute bladder management included indwelling urethral catheters have been converted to an ICP with most achieving a catheter-free state. Thirty-one percent of these patients were observed to have some degree of pyelocaliectasis on the most recent excretory urogram. Patients with incomplete lesions had equal or greater risk of developing pyelocaliectasis than patients with complete lesions. Right side predominance of pyelocaliectasis was also demonstrated. Grading each renal unit suggested the more severe degrees of pyelocaliectasis were evenly distributed between the right and left sides, while less severe pyelocaliectasis was observed predominantly on the right side. When repeat evaluations of mild pyelocaliectasis were made, it was found that 56% reverted back to normal, whereas 44% continued to have minimal or progressive worsening of pyelocaliectasis on excretory urograms.

APPLICABILITY: Since introduction of the ICP at this Center six years ago, a large amount of data have been collected on patients who enter the program. These data are being analyzed to evaluate long-term effects of catheter removal. Long-term follow-up evaluation is necessary to prove or disprove the efficacy of the catheter-free state as the method of choice of bladder drainage in patients with neurogenic bladders secondary to spinal cord injury.

226 Pain in Spinal Cord Injury

Principal Investigator: Cecil S. Nepomuceno, M.D.
Status: Completed
Dates: June 1976-September 1978
Cost: Not applicable
Annual Report Reference: #13, Page 143, R-58

OBJECTIVES

1. To characterize pain as it occurs and is described by a series of spinal cord injury patients.
2. To analyze and evaluate these characterizations in terms of psychological, physical and demographic variables on a patient specific and series basis.

METHODOLOGY: Spinal cord injury patients with lesions of at least 12 months duration were asked to respond to a series of questions about their condition and any associated discomfort/pain. Criteria for inclusion in the study do not include level or extent of lesion or nature of associated injuries, although these variables will be subject to consideration when data are ultimately analyzed.

The relationship between the experience of persistent pain in spinal cord injury and medical-descriptive, demographic, psychological and familial-social data was studied. Multiple linear regression and discriminant analysis were used to predict (1) presence or absence of pain; (2) severity of pain (patient rating of mild, moderate, severe, extreme); (3) time post-injury onset of pain; and (4) whether pain interfered with activities of daily living.

FINDINGS TO DATE: 200 of 356 questionnaires (56%) were completed and categorized into 4 groups by level of lesion. 160 subjects (80%) reported having experienced pain they believe to be associated with the spinal cord injury. These patients were asked to describe the nature of the pain utilizing a wide variety of objective and subjective descriptors.

The reported incidence of pain was higher among patients whose lesions were at the neurologic level of T7 or below. Pain occurred within 6 months of injury of 65% of those patients who reported pain. Patients with cervical cord injuries most often experienced upper extremity pain; trunk pain was more common among patients with upper thoracic injuries; lower extremity pain was most often experienced by patients with lower thoracic and cauda equina lesions. 64 patients reported their pain interfered with daily living activities. 32 patients indicated their pain grew more severe with time, while only 12 patients indicated a diminution of pain. Patients with low level lesions were more willing to "trade-off" any possibility of recovery and/or loss of regained physiologic function for pain relief than were patients whose lesions were at a higher neurologic level.

The best combinations of predictor variables accounted for only fifteen percent of the variance in the dependent measure of pain vs. no-pain, and only nineteen percent of the variance in onset of pain. The best combinations of predictor variables accounted for forty-three and forty-four percent of the variance, respectively, of the dependent measures of severity of pain and whether pain interfered with activities of daily living. Higher levels of subjective pain were associated with greater age, higher verbal intelligence, higher levels of anxiety and a more negative psycho-social situation. Persons who reported that pain interfered with activities of daily living were more likely to be older, of higher intelligence, more depressed, clinically rated as experiencing greater levels of distress and immersed in a more negative psycho-social environment.

The retrospective nature of this study makes it difficult to draw inferences about causality. It does validate the importance of psycho-social variables in the understanding of persistent spinal cord injury pain and argues for prospective studies along these lines.

APPLICABILITY: Information gathered from this study can be immediately utilized by clinicians, therapists, psychologists and vocational counselors in spinal cord injury rehabilitation programs. These data may prove useful to the professional rehabilitation specialist in assessing, evaluating and accurately determining the impact and role of pain as it influences or affects the rehabilitation process. The findings may lend insight into the physical and psycho-dynamic aspects of the phenomenon as it occurs in spinal cord injury and may assist rehabilitation specialists in creating realistic goals for the patient/client.

227 Assessment and Evaluation of Home Health Team Activities

Principal Investigator: Philip R. Fine, Ph.D.
Status: Completed
Dates: June 1976-May 1978
Cost: Not applicable
Annual Report Reference: #13, Page 519, R-61

OBJECTIVES

1. To examine, assess and otherwise evaluate Home Health Team activities including miles traveled, personnel and travel-related costs, number of patients visited, frequency or regularity of visits, etc., since the time of inception and implementation of the Home Health Team to the present.
2. To identify patient problems encountered by providers of home care.
3. To evaluate health status of patients visited by Home Health Team personnel and to compare this status with a matched cohort who has not been visited regularly by Home Health Team personnel.
4. To identify and otherwise assess the availability of professional and paraprofessional resources in the various counties of Alabama and to compare these numbers with the location of Home Health Team patients' residences.
5. To evaluate, assess and otherwise determine feasibility of expanding the scope and frequency of services to homebound clients by changing the functional activities of Home Health Team personnel from direct patient care to training of professionals and paraprofessionals who will become responsible for providing patient care in their particular county or geographic subdivision.

METHODOLOGY: A classical administrative/management analysis (detailed fiscal analyses, evaluation of duties, time in field, medical conditions treated, total costs, etc.) was conducted. A statistical analysis of the health status of a sample of spinal cord injury victims who were former patients of this Center and who have been treated with varying frequencies by the Home Health Team was completed. The availability and accessibility of health manpower and resources in the State were examined.

FINDINGS TO DATE: The Home Health Team related cost per spinal cord injury patient on Home Health Team rolls has declined steadily since 1973. The cost per active patient in 1977 was determined to be \$150. The cost per visit averaged \$144 over the lifetime of the project and has been relatively constant since 1973. Trips to patients' homes averaged 75 miles per visit. A systems analysis of Home Health Team activities suggests a well run and reasonably efficient operation. The data suggest that a team operating under similar conditions (e.g., geographic and demographic) can conduct approximately 300 visits annually, if in the field two days per week, 50 weeks per year.

An additional substudy was conducted which identified the medical complications and other related problems among spinal cord injury patients following hospital discharge. Architectural barriers were the most common problem identified during the predischARGE visits to the patient's place of residence. On postdischarge follow-up visits, the two most common problems encountered by the nurse and physical therapist were noncompliance with recommended therapeutic procedures and skin breakdowns, each of which was recorded on the majority of home visit reports. Patients visited frequently by the Home Health Team had more medical and psycho-social problems associated with their disability than did their less frequently visited counterparts.

For additional information please refer to:

1. Better, S.R., Fine, P.R., Celes, G.W. and Owen, E.N. Medical Complications and Other Related Problems Identified Among Spinal Cord Injury Patients Following Hospital Discharge. *ARN Journal* 4, 2, 8-10, 1979.

2. Fine, P.R., Better, S.R. and Engstrand, J.L. Assessment and Evaluation of a Hospital Based Specialty Home Health Team. *Journal of Association of Rehabilitation Nurses* III, 1, 5-11, 1978.

APPLICABILITY: Findings from this study will assist other rehabilitation centers in determining whether similar activities are economically feasible and cost-effective modalities for providing on-going follow-up care for spinal cord injury patients as well as other severely disabled persons.

228 Effect of Dantrolene Sodium on the Efflux of Calcium from Isolated Sarcoplasmic Reticulum Vesicles

Principal Investigator: Kennon T. Francis, Ph.D.
Status: Completed
Dates: June 1977-June 1980
(completed ahead of schedule)
Cost: Not applicable
Annual Report Reference: #13, Page 197, R-64

OBJECTIVES

1. To examine the calcium sequestering and release parameters of sarcoplasmic reticulum from rabbit skeletal and rat cardiac muscle.
2. To examine the effects of dantrolene on the sequestering and release of Ca^{++} from the sarcoplasmic reticulum of rabbit skeletal and rat cardiac muscle.
3. To increase knowledge of basic mechanisms whereby dantrolene effects muscle relaxation.

METHODOLOGY: The sarcoplasmic reticulum vesicles were prepared from rabbit skeletal muscle by the method of Fairhurst. The vesicles were partially loaded with calcium oxalate by incubating for 7 minutes at 30°C with 3 ml of uptake medium containing ^{45}Ca labelled CaCl_2 , ATP, EGTA, KCl, MgCl_2 , potassium oxalate, and imidazole at pH 7. Then, 97 ml of efflux medium was added. Various drugs and/or calcium were added to the efflux medium to test their effect on efflux of ^{45}Ca . Samples were removed at 1, 5, 10, and 15 minutes after addition of the efflux medium, rapidly filtered, and aliquots counted in a liquid scintillation counter. Protein was determined by the method of Lowry et al. Based on these initial studies, the efflux media was modified to obtain the optimum ratio of calcium, rat cardiac sarcoplasmic reticulum vesicles. Data were analyzed using Lineweaver-Burk plots.

FINDINGS TO DATE: Dantrolene concentrations of 4 to $9 \times 10^{-5}\text{M}$ suppressed the efflux of Ca^{45} from the isolated vesicles in a dose-related way during the first five minutes of incubation. The residual Ca^{2+} in the sarcotubular vesicles was inversely related to the dantrolene concentrations of 4, 6 and $9 \times 10^{-5}\text{M}$. The addition of 10mM caffeine to the efflux media offset the suppressive effects of the lower concentrations of dantrolene on Ca^{2+} efflux. Only dantrolene concentrations of $9 \times 10^{-5}\text{M}$ resulted in significant retention of Ca^{2+} in the vesicles in the presence of 10mM caffeine. For additional information, please refer to: "The effect of dantrolene sodium on the efflux of Ca^{45} from rat heavy sarcoplasmic reticulum." Kennon T. Francis, Ph.D. *Research Communications in Chemical Pathology and Pharmacology*, 21, 3, 573-576, 1978.

APPLICABILITY: The problems of spasticity and abnormal performance present a major challenge to those involved in rehabilitation. Since spasticity appears to impede motor recovery and performance, an agent which relieves spasticity might be expected to improve motor performance. Dantrolene sodium has been found to be beneficial in the treatment of spasticity in many patients. This study should provide further evidence regarding the efficacy and mechanism of action of dantrolene. The data will be useful in planning drug regimes for controlling spasticity, maintaining beneficial changes and interpreting side effects.

229 Frequency and Volume of Urination in Patients with Spinal Cord Injuries

Principal Investigator: L. Keith Lloyd, M.D.
Status: Completed
Dates: June 1977-June 1979
Cost: Not applicable
Annual Report Reference: #13, Page 225, R-66

OBJECTIVES

1. To determine the capabilities of a newly developed uroflowmeter, and the ease with which it can be applied to clinical situations.
2. To determine the pattern of voiding events in patients with neurogenic bladder secondary to spinal cord injury.

METHODOLOGY: A uroflowmeter was devised which records time and volume of micturition. The study population will be divided into three groups (1) patients with recent spinal cord injuries who are admitted for initial evaluation and therapy, (2) patients who are readmitted for follow-up examination or for treatment of specific problems, and (3) patients who are rehospitalized for external sphincterotomy. All patients will undergo a cystometrogram with simultaneous electromyography of the external sphincter as well as urethral pressure profiles. Intravenous pyelograms (IVP) and the results of the most recent examination will be evaluated for all patients. However, excretory urograms and cystograms will not be a specific prerequisite for admission into the study population.

FINDINGS TO DATE: Urine voiding patterns from mid-afternoon to the following morning (16 hours) have been measured, using two completely new uroflowmeter systems designed and built during the past year.

A total of 39 patients have been studied to date; five patients were tested before and after sphincterotomy; 18 recent "graduates" and 16 old (7 months or more after successful completion) "graduates" of the intermittent catheterization program (ICP) were also studied.

The mean ($\bar{x}$) void-volume for recent ICP "graduates" was 91 mls, and the mean ($\bar{x}$) intervoid interval for these patients was 56.9 minutes. Void-volumes varied greatly ranging from 10-30 mls in one patient to 10-690 in another.

The mean ($\bar{x}$) void-volume among patients who had successfully "graduated" from the ICP seven or more months prior to the study was 62 mls, substantially less than the mean ($\bar{x}$) void-volume of the recent ICP graduates. Moreover, the mean ($\bar{x}$) intervoid interval was 43.2 minutes which was somewhat shorter than the intervoid interval of the recent graduates. This finding indicates that older graduates void more frequently, but have smaller voided volumes, than recent graduates. The range of the mean ($\bar{x}$) intervoid interval varied from a low of 7.8 minutes to a high of 154.7 minutes, while the mean ($\bar{x}$) void-volume ranged from 21 mls to 247 mls.

Among patients who had undergone sphincterotomies, the mean ($\bar{x}$) volume voided was 35 mls and the mean ($\bar{x}$) intervoid interval was 56.7 minutes prior to surgery. Following surgery, the mean ($\bar{x}$) voided volume was 26 mls and the mean ($\bar{x}$) intervoid interval was 17 minutes. Therefore, urine output was substantially higher following sphincterotomy than before surgery.

APPLICABILITY: If the clinical usefulness of the uroflowmeter is verified, it can be used by urologists and physiatrists in various settings. If the uroflowmeter increases the accuracy of diagnosis or if it can replace more expensive diagnostic procedures, it could assume a role in standardized urological examinations and patient management practices.

230 Effects of Spinal Cord Injury on Helpless Behavior: A "Real World" Application of Seligman's Learned Helplessness Theory

Principal Investigator: Rosemary Wool, Ph.D.
Status: Completed
Dates: June 1978-June 1980
(completed ahead of schedule)
Cost: Not applicable
Annual Report Reference: #13, Page 535, R-72

OBJECTIVES:

1. To adapt traditional learned helplessness assessment tasks (verbal and motor) for use with spinal cord injured patients.
2. To utilize modified learned helplessness tasks to determine whether personality and coping styles (e.g., passivity, dependency, depression, etc.) of the spinal cord injured differ from those demonstrated by non-injured subjects.

METHODOLOGY: The experimental procedure for this study was the traditional learned helplessness paradigm, a three part, triadic design. All subjects received one of three pretreatments, followed by the solvable cognitive and instrumental tests. The following pretreatment groups were formed: (1) spinal cord injured subjects, helplessness training, (2) spinal cord injured subjects, no training, (3) spinal cord injured subjects, control training, (4) other injured subject, helplessness training, (5) other injured subjects, no training, and (6) other injured subjects, control training.

FINDINGS TO DATE: Results of this study lend further support to the validity of the learned helplessness theory. Subjects who were administered helplessness training demonstrated performance deficits, compared with subjects receiving control or no training. In addition, subjects given control training demonstrated immunization effects relative to other subjects. However, differential helplessness and immunization effects for the two injury groups were not observed. It appears methodological problems, associated with the subject selection criteria and the brevity of the pretreatment tasks, were the major reasons for the nonsignificant results regarding the type of injury variable.

Of interest is that learned helplessness effects occurred without experimental emphasis upon attributional variables, such as task difficulty or importance. Thus, this research suggests the more parsimonious, nonrevised learned helplessness theory is still a meaningful, applicable one. While attributional dimensions have been an important addition to learned helplessness theory, they have, to a large extent, complicated and qualified the theory. Results from this study indicate performance deficits and enhancements occur because of pretreatment conditions, when these conditions are powerful enough, and that it is not necessary to invoke attributional concepts to interpret results.

Results from this study also seem of significance to rehabilitation counseling. They suggest that newly injured spinal cord patients, during their initial rehabilitation, are experiencing a period of denial, or unrealistic optimism about the extent and significance of their disability. It is likely rehabilitation staff, through their continuous encouragement, aid in this denial. In many respects, this rehabilitation environment is like the control training subjects received in this study. Both serve to immunize against subsequent failure. Following their initial recovery, spinal cord injured patients seldom receive the degree of support provided by rehabilitation staff. It is likely this initial support, or control training, is insufficient immunization to prevent the development of helplessness feelings after discharge. While further documentation, using learned helplessness behavioral measures, is necessary, previous research and clinical observations support the hypothesis that depression and helplessness more strongly coincide with discharge from the rehabilitation center, rather than with admission to it. If future research supports this premise, then supportive counseling, following discharge, may be an effective method of continuing to immunize patients, or of at least helping them attenuate the intensity of the depression and helplessness feelings that often accompany spinal cord injury.

APPLICABILITY: In this project, the existence of distinct personality and coping styles differentiating spinal cord injured patients from non-paralyzed individuals will be studied. The learned helplessness paradigm, a relatively new behavior measure of personality traits developed by Seligman, is the method to be used.

This project will contribute to the literature addressing the psychological aspects of spinal cord injury and help rehabilitation workers plan and provide appropriate services for these patients.

231 Effect of Disodium Etidronate on the Recurrence of Ectopic Calcification Following Surgical Removal

Principal Investigator:	Samuel L. Slaver, M.D.	
Status:	Continuing	
Dates:	October 1970-June 1980	
Cost:	Annual \$21,570 RI Annual \$20,570	Project Total (not specified) RI % of Annual Total 95%
Annual Report Reference:	# 13, Page 47, 9-13	

OBJECTIVES

1. To demonstrate the effectiveness of disodium etidronate in preventing postoperative recurrence of heterotopic ossification (HO) in patients with spinal cord injury, ankylosing spondylitis and other severe neurological conditions in which surgical excision of the heterotopic bone is indicated.
2. To demonstrate that the prevention of postoperative recurrence allows greater joint range of motion and improves function.

METHODOLOGY: This long-term study has utilized three protocols. The patient population was restricted to persons 16 years of age or older who suffered spinal cord injuries or who, because of other severe neurological injuries or illnesses, developed HO requiring surgical intervention. The experimental drug, EHDP, is administered both pre- and postoperatively for varying periods of time. In the first protocol completed in 1974 the patient served as his/her own control. Subsequent protocols were double-blind studies distinguishable by the length of postoperative administration of drug and dosage following surgery. Patients are followed closely correlating laboratory studies, clinical course, joint range of motion and x-ray findings to evaluate the efficacy of the drug.

FINDINGS TO DATE: Initial Studies: The first four patients participating in this study served as their own control. Without drug treatment, surgical wedge resections were followed by postoperative recurrence. Repeat surgery was deferred until the alkaline phosphatase level returned to normal. The patients were then started on EHDP.

Encouraging results led to the development of a double-blind study. Patients entering the study were assigned randomly to a treatment group (placebo or EHDP). Medication was administered in an approximate dosage of 10 mg/kg/day for one year postoperatively.

Surgery: Wedge resections of the central part of the heterotopic bone mass were performed allowing hip flexion to at least 90°. Each case had an anterior iliofemoral bar which restricted hip motion. These masses were all approached through a standard anterior iliofemoral incision. In all cases, the hip joint capsule could be easily identified and the bony mass separated from its external surface. As soon as the hip joint was freed, motion was tested and resection was continued, both proximally and distally, until 90° of hip flexion could be obtained.

Preoperative and Postoperative Care: Careful attention was given preoperatively to the condition of the skin and urinary tract. Surgery was delayed in patients with open pressure ulcers until healing was complete, and specific antibiotic treatment was given, when necessary, before surgery to sterilize the urinary tract. The antibiotic treatment was continued approximately one week postoperatively.

Complications and Side Effects: Surgical complications were limited to: (1) hemorrhage postoperatively from the drain sites requiring blood transfusions in two patients, (2) anticipated seroanguinous fluid accumulation in the dead space and (3) the development of a soft tissue

infection in one patient in the incisional area which healed completely after several weeks, but two years later developed a hip abscess resulting in osteomyelitis of the hip joint area.

Side effects of EHDP included only expected elevations of serum phosphate which has no known clinical effects, mild nausea and abdominal discomfort in one patient, which was controlled by giving EHDP in divided doses. Lack of other laboratory or clinical side effects in the parameters studied suggests EHDP's safety for clinical use.

During the past year, follow-up was continued on the study population who were still receiving EHDP or placebo therapy and also other patients who had already completed drug therapy were further evaluated for any recurrence of heterotopic ossification. Joint range of motion was also followed.

The entire study population consists of 16 patients who have undergone a total of 26 surgical procedures. Further breakdown of the procedures reveals removal of heterotopic bone occurring about the hip in 15 patients (25 procedures) and removal of heterotopic bone occurring about the elbow in one patient (one procedure).

In general, it appears that EHDP prevents the postoperative recurrence of heterotopic ossification during the course of drug treatment, whereas, recurrence during the control study or placebo therapy in certain patients is almost inevitable.

It is becoming obvious that patients with head injuries who have heterotopic ossification have much less likelihood for postoperative recurrence than the patients who have spinal cord injury. It also appears that patients with incomplete spinal cord injury with some motor recovery at the time of heterotopic ossification excision, have less recurrence than patients with complete spinal cord injury.

After drug termination, the extent of heterotopic ossification recurrence appears to be inversely proportional to the size of the initial bone mass and length of treatment. The maturity of heterotopic ossification at the time of surgery does not seem to influence the effects of EHDP treatment, but may influence the extent of recurrence after drug withdrawal depending on the length of EHDP treatment.

In summary, EHDP is the first therapeutic agent with definite effectiveness in delaying and partially preventing recurrent postoperative heterotopic ossification.

APPLICABILITY: HO is a common complication of spinal cord injury necessitating absenteeism and surgical removal when sufficiently severe to inhibit range of motion of the joints, particularly the hips, to make the patient functionally as independent as possible and prevent the usual recurrence of ectopic bone.

This drug shows considerable promise in preventing recurrence of ectopic bone (HO) formation after surgical excision.

232 Renal Scintillation Camera Studies as a Method of Following Renal Function and Urological Management in Spinal Cord Injury Patients with Neurogenic Bladder

Principal Investigator:	Samuel L. Slaver, M.D.	
Status:	Continuing	
Dates:	June 1976-May 1981	
Cost:	Annual \$60,451 RT Annual \$53,951	Projected Total \$770,927 RT % of Annual Total 89%
Annual Report Reference:	#13, Page 77, B-56	

OBJECTIVES

1. To compare results of the comprehensive renal scintigraphy procedure (CRSP) and plain film KUB x-rays with the excretory urogram in a series of SCI patients with neurogenic bladder to identify changes in renal function detected by the scintigraphic technique and to correlate these

changes with visible anatomic and/or gross functional changes revealed by plain film KUB x-rays and excretory urograms.

2. To compare post-void residual urine volumes measured by renal scintigraphy to volumes obtained by catheterization.
3. To compare results of renal function measured using the CRSP to laboratory measurements of serum urea nitrogen and serum creatinine.
4. To compare abnormalities identified on cystourethrography to functional results obtained using the CRSP and plain film KUB x-rays.
5. To develop and test a predictive model for future urinary tract complications using past and present values of results from the CRSP, excretory urogram, cystourethrogram, plain film KUB x-ray and blood chemistry procedures.

METHODOLOGY: Morphological and functional assessment of the genitourinary system have been performed in a series of spinal cord injury patients with accompanying neurogenic bladder using two diagnostic routines: (1) CRSP and plain film x-rays of the kidneys, ureters and bladder; and (2) excretory urograms, residual urine volume measurements, serum urea nitrogen and serum creatinine determinations and cystourethrograms during the initial hospitalization and/or regularly scheduled follow-up evaluations. Test results from the two diagnostic routines will be examined to determine the comparability of data derived from various procedures. Regression equations, correlation coefficients and other statistical expressions will be calculated to determine the sensitivity and specificity of each measure.

FINDINGS TO DATE: To date, 439 renal scintillation camera studies have been performed on spinal cord injury patients. A comparison has been made with excretory urogram in 356 patients. A detailed analysis of compared results of the excretory urogram and the renal scintillation camera study has been made in 211 patients. The information from this review was presented at the American Spinal Injury Association in Atlanta in March of 1979 and at the American Urological Association meeting in New York in May of 1979. It would appear at this point the renal scintillation camera study may be able to serve as a screening test in spinal cord injury patients in lieu of an excretory urogram. Additionally, the renal scintillation camera study detects abnormalities that are not revealed on excretory urograms. Further study is continuing with serial examinations being conducted in these patients. The significance of these findings will, hopefully, be determined as the study continues. To date, 103 patients have had a second renal scan performed and 9 patients have had a third scan performed. Serial exams with three to four renal scans performed in each patient will be helpful in analyzing the significance of the abnormalities demonstrated on renal scan when the excretory urogram is normal.

No patient has had an adverse reaction to the renal scintillation camera study and virtually all patients have found it to be a far more tolerable testing procedure than the excretory urogram.

APPLICABILITY: The spinal cord injured patient with neurogenic bladder often has multiple urological complications which may progress to renal failure and death. Of death occurring in spinal cord injury patients, approximately 50% are renal deaths. Urological problems often prolong the disability, require protracted or repeated hospitalization, and may preclude some of these severely disabled patients from returning to vocational pursuits. Improved and less complicated methods for evaluating renal function in these patients should facilitate urologic management, decrease costs of associated hospitalization and allow more continuity of vocational activities as well as prolong the life of the patient.

233 Bowel Regulation in Spinal Cord Injury

Principal Investigator:	Cecil S. Nepomuceno, M.D.	
Status:	Continuing	
Dates:	June 1977-June 1980	
Cost:	Annual \$16,354	Projected Total \$23,282
	RT Annual \$16,354	RT % of Annual Total 100%
Annual Report Reference:	#13, Page 183, R-63	

OBJECTIVES:

1. To determine the medical appropriateness and patient acceptability of a bowel training program for spinal cord injury patients utilized by this Rehabilitation Center.
2. To document individual modifications of the established program instituted by the spinal cord injury patient following hospital discharge.
3. To identify bowel program modifications initiated by the successfully rehabilitated spinal cord injury patient which might be integrated into the established program utilized by this Rehabilitation Center.

METHODOLOGY: Forty spinal cord injury patients with complete lesions will participate in a bowel training program while hospitalized at the Rehabilitation Center. At patient discharge, measures of medical appropriateness and patient satisfaction will be collected. The patient's bowel program status will be reassessed upon return to follow-up medical examinations for a period of five years. Individual modifications of the established program instituted by the patient following discharge will be documented.

FINDINGS TO DATE: Twenty-six spinal cord injury patients who agreed to participate in this project have been discharged from Spain Rehabilitation Center/RT-19.

The second annual data collection interview has been conducted on one patient. Annual data have been collected on ten additional patients. Remaining patients will be so interviewed at the one-year and subsequent anniversaries of their injury.

Additional patients are being identified and data continue to be collected. A number of the subjects interviewed for annual review have indicated implementation of minor variations of the bowel program initiated during rehabilitation. The vast majority of patients, however, are adhering to the parameters of the original bowel program. The significance of these findings cannot, as yet, be evaluated. Analyses of findings are not being pursued at this time.

APPLICABILITY: Bowel training is an important component of any comprehensive rehabilitation program for spinal cord injury patients. The bowel training program must be satisfactory to the physician and acceptable to the patient as well. If a successful bowel training can be instituted early in the rehabilitation process, the patient's long-term potential for vocational rehabilitation may be enhanced.

234 Electromyographic Findings in Spastic and in Flaccid Spinal Cord Injury

Principal Investigator:	Cecil S. Nepomuceno, M.D.	
Status:	Continuing	
Dates:	June 1977-June 1980	
Cost:	Annual \$19,417 RT Annual \$17,417	Projected Total \$50,849 RT % of Annual Total 90%
Annual Report Reference:	#13, Page 209, R-65	

OBJECTIVES: To demonstrate positive sharp waves and fibrillation potentials resulting from UMN lesions and to distinguish them from similar electrical activity observed in LMN lesions. Demonstration of spontaneous activity will be achieved by use of electromyography. Differentiation will be attempted utilizing previously developed computer-assisted analysis procedures.

METHODOLOGY: 50 spinal cord injury patients neurologically complete lesions at the level of T10 or above will constitute the study population. These patients will be divided equally into two groups on the basis of flaccidity or spasticity of the lower extremities. A TECA, Model 4, Electromyograph will be used. The proximal middle and distal areas of both quadriceps, as well as the medial and lateral hamstrings will be examined. Positive sharp waves and/or fibrillation potentials will be recorded on magnetic tapes and light sensitive paper and graded. The magnetic tapes will be analyzed by computer to extract parameters from positive sharp waves and fibrillation potential located by the program. For the positive sharp waves, an oscilloscope will be used to identify the locations of segments containing data of interest. These will include well-defined sequences of

positive sharp waves in which individual wave packets can be identified. Parameters for each wave packet will be determined and subjected to an analysis of variance to yield differences between lesions.

FINDINGS TO DATE: Forty-two (of 50 projected) spinal cord injury patients meeting the criteria for inclusion in the study have been tested to date. Those studied included 36 subjects with spastic lower extremities and 6 subjects with flaccid lower extremities; of these only 12 spastic and 4 flaccid subjects were found to have recordable positive sharp waves and fibrillation potentials and could, therefore, be included in the data set. Patients will continue to be identified and tested until the projected number of subjects, in each category, has been achieved. Data will be analyzed at one time, near the end of the project period.

APPLICABILITY: The information and findings gathered in this study can be immediately utilized by medical and paramedical personnel managing spinal cord injured patients. The procedures applied here can disclose the pathological state of the spinal cord segment below the level of injury, specifically the integrity of the spinal center for bowel, bladder and sexual regulation.

235 Mechanisms of Pyelonephritis in Spinal Cord Injured Patients

Principal Investigator:	George P. Hemstreet, M.D., Ph.D.	
Status:	Continuing	
Dates:	June 1977-June 1982	
Cost:	Annual \$57,407 RT Annual \$46,407	Projected Total \$327,719 RT % of Annual Total 81%
Annual Report Reference:	#13, Page 241, R-67	

OBJECTIVES: To investigate the mechanisms involved in kidney tubule cell destruction in chronic pyelonephritis.

METHODOLOGY: In the first phase of this project kidney tubule cells from rat and human kidneys will be cultured. The cells will then be radiolabeled with Cr^{51} radioisotopes. The second phase focuses on the development of the Cr^{51} microcytotoxicity assay and the growth of gram negative E coli bacteria and the preparation of lipopolysaccharides. In the final phase, various cytotoxic mechanisms will be investigated that may be involved in kidney tubule cell destruction. These mechanisms include measurement of direct cell mediated cytotoxicity and antibody dependent cellular cytotoxicity. Target cells include normal cultured kidney cells, normal cultured kidney cells treated with lipopolysaccharides, and normal cultured kidney cells incubated with bacterial exotoxins.

FINDINGS TO DATE: Injection of purified lipopolysaccharide from *Salmonella typhimurium* Re 595 into the kidneys of rats, resulted in the production of autoantibody to cultured rat kidney tubule cells. Absorption of this immune serum of normal rat kidney tubule cells caused a decrease in the killing. Induction of autoantibody by i.p. injection suggests there are antigens on the LPS which are cross reactive with antigens present on cultured rat kidney tubule cells. Sham and saline injections alone do not cause the production of autoantibody.

Examination of injected kidneys revealed marked inflammatory response in rats injected with LPS. In responder strains of mice the inflammatory response was also pronounced. In saline injected rats and in non-responder mice injected with LPS there was little inflammatory response.

A rat pyelonephritis model was established using *Proteus mirabilis* as the injecting organism. Serum taken from infected rats was used in antibody mediated cytotoxicity tests but did not result in any significant killing of autologous rat kidney tubule cells.

Antibody-dependent cell mediated cytotoxicity (ADCC) tests were also done in both the human and rat systems. In preliminary tests, normal human lymphocytes in conjunction with rabbit anti-human kidney antibody resulted in approximately 28% cytotoxicity. Normal rat lymphocytes in conjunction with rabbit anti-rat kidney antibody effected about a 5% kill. Low killing in the rat system is believed to be caused by a lack of cells in the rat species. Instead, normal human

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lymphocytes and rabbit anti-rat kidney antibody were tested against normal rat kidney cells. Cytotoxicity increased from 5% to 15% in the modified system.

ADCC tests were also done using the post-surgical lymphocytes and pre-surgical serum of a person operated on for chronic pyelonephritis.

Preliminary experiments, while inconclusive, indicate a possible cytotoxicity of 13%.

Tests were also conducted using either human activated lymphocytes or activated macrophages. Their ability to cause cell death was examined. Preliminary results indicate activated macrophages will kill normal human kidney cells.

APPLICABILITY: A more precise understanding of immunologic mechanisms associated with pyelonephritis will be useful in developing more appropriate techniques for the management of urinary tract infection and recurrent pyelonephritis. Understanding host-defense mechanisms may be important in prevention of acute and chronic pyelonephritis.

236 Effect of Dantrolene Sodium on the Mixed Function Oxidase System of Rat Liver

Principal Investigator: Kennon T. Francis, Ph.D.

Status: Continuing

Dates: July 1978-June 1980

Cost: Annual \$19,693 Projected Total \$42,773
RT Annual \$18,493 RT % of Annual Total 94%

Annual Report Reference: #43, Page 287, R-68

OBJECTIVES:

1. To study the metabolism of hexobarbital in male and female rats pretreated with acute doses of dantrolene.
2. To study the metabolism of ethylmorphine and determine the amount of cytochrome P-450 and NADPH reductase in rats pretreated with acute doses of dantrolene.
3. To study the ability of the mixed function oxidase system to be induced by phenobarbital with the simultaneous administration of dantrolene.
4. To study the dose effect relationship of dantrolene on the metabolism of ethylmorphine.
5. To study the recovery of the mixed function oxidase system after pretreatment with dantrolene.
6. To study the effect of dantrolene on the adrenal cortex and glucocorticoids.

METHODOLOGY: Rats will be pretreated with varying dosages of dantrolene. hexobarbital, phenobarbital or cortisone will also be administered to some animals.

Drug administration will be followed by measurement of sleeping periods, ability to metabolize ethylmorphine, amounts of cytochrome P-450, NADPH reductase activity and cortisol, and/or adrenal gland weight.

FINDINGS TO DATE: An investigation of the effect of dantrolene pretreatment on pentobarbital sleeping time indicated that dantrolene inhibited the activity of the hepatic Mixed Function Oxidase (MFO) system. Prolongation of sleeping time was dose related and was greater after five days pretreatment than after one day pretreatment.

The inhibition of the hepatic MFO system by dantrolene was confirmed by experiments investigating the effect of pretreatment with 25 or 100 mg/kg of dantrolene on various *in vitro* parameters of hepatic MFO system activity. One day pretreatment with 25 mg/kg of dantrolene did not alter drug metabolizing activity, but five days pretreatment did decrease aminopyrine N-demethylation by approximately 46%. This decrease in metabolism was not associated with a change in the apparent Km for aminopyrine, a change in hexobarbital binding, or a change in cytochrome P₄₅₀ content.

One day pretreatment with 100 mg/kg of dantrolene caused a 55% decrease in aminopyrine N-demethylation which was associated with a 50% decrease in cytochrome P₄₅₀ content. A 45% decrease in the A_{max} for hexobarbital binding, and significant increase in the K_s for hexobarbital binding. A single dose of 400 mg/kg of dantrolene produced similar effects on the hepatic MFO system.

One day pretreatment with 100 mg/kg of dantrolene did not alter the ability of phenobarbital to induce the MFO system. Also, five days pretreatment with 100 mg/kg of dantrolene did not block the ability of 3-methylcholanthrene to induce the MFO system. The data indicate that dantrolene, as well as phenobarbital and 3-methylcholanthrene tend to increase the milligrams of microsomal protein per gram of liver. In fact, the dantrolene and phenobarbital appear to have an additive effect.

All rats receiving the higher dosages of dantrolene for a period of 5 days had marked and consistent weight loss. Comparison of the liver of body weight ratio revealed no alteration in the control or dantrolene treated ratio and histological examination of the liver revealed no evidence of necrosis or injury.

APPLICABILITY: Dantrolene sodium became commercially available in 1974 and has been used to decrease skeletal muscle spasticity in patients with various disorders. However, hepatotoxicity is one reported adverse effect of this drug which should be considered in further detail. Clarification of the site of drug action in the liver is necessary so possible precautions may be taken by physicians prescribing the drug.

237 Development and Evaluation of a Communications, Control, Education and Entertainment System (C2E2) for the Severely Disabled Based Upon Commercially Available Microcomputer Systems

Principal Investigator:	James Rogers, Chief Biomedical Electronics Section	
Status:	Continuing	
Dates:	October 1978-March 1981	
Cost:	Annual \$36,558 RT Annual \$37,558	Projected Total \$83,000 RT % of Annual Total 100%
Annual Report Reference:	#13, Page 317, R-69	

OBJECTIVES:

1. To develop and demonstrate the usefulness and economic feasibility of microcomputer system applications for purposes of communication, environmental control, computer aided instruction (CAI) and entertainment for persons with severely disabling conditions.
2. To disseminate system information and otherwise promote, encourage and stimulate further applications and expanded utility via the development of additional software and hardware.
3. To solicit, evaluate and disseminate software and hardware designs created expressly for use by the severely physically disabled.

METHODOLOGY: A model multi-purpose microcomputer system for use by the severely disabled will be designed and constructed using commercially available and custom-made system components. Appropriate software will also be developed, implemented and refined. Project-related system information will be disseminated to the rehabilitation community, microcomputer enthusiasts, potential user groups, etc.

FINDINGS TO DATE: The model multi-purpose system for use by the severely disabled has been designed and constructed. Its usefulness and economic feasibility for purposes of communication, environmental control, computer aided instruction (CAI) and entertainment have been demonstrated.

The investigators are presently involved in software development. The television control, power control and clock/calendar section of the Master Control Program have been completed. The

telephone control section needs only the addition of a directory of numbers, while the education/instruction section needs additional CAI programs adapted for voice input. Work on the text writer and the games/music sections has been initiated and is nearing completion.

APPLICABILITY: Successful development of a microcomputer system for use by the severely physically disabled, coupled with the involvement of computer hobbyists in the development of future hardware and software improvements, will allow patients to address many physical needs and perform numerous activities of daily living with minimal assistance from family members or attendants.

Utilization of units for environmental control, communication, entertainment and education also will meet numerous psychological as well as physical needs of the severely physically disabled.

238 Effects of Abdominal and Lower Limb Compression on Cardiopulmonary Response and Energy Cost in High Spinal Cord Injury Patients

Principal Investigator:	Chi-Tsou Huang, M.D.	
Status:	Continuing	
Dates:	June 1978-June 1980	
Cost:	Annual \$52,295 RT Annual \$52,295	Projected Total \$105,000 RT % of Annual Total 100%
Annual Report Reference:	#13, Page 419, R-70	

OBJECTIVE:

1. To determine the value of pneumatic compressive devices in preventing the occurrence of orthostatic hypotension among patients having recent injuries to the cervical spinal cord.

METHODOLOGY: Using the Mobile Automatic Metabolic Analyzer (M.A.M.A.), data will be collected on metabolic responses of spinal cord injury patients during movement to and maintenance of six predefined postural changes while wearing an inflatable abdominal corset or bilateral pneumatic leg splints. Cardiopulmonary responses will also be monitored.

FINDINGS TO DATE: As of late April, 1979, the investigative team had completed one pilot study and 3 experimental test subjects. All data have been analyzed. All subjects were tested according to the established protocol. This included energy expenditure measurements without compressive devices, with the abdominal corset and with pneumatic leg splints. Comparisons of inspiratory, expiratory volume and energy costs in different angles of tilt are being made at present.

Due to an insufficient number of spinal cord injury patients admitted to this Center with neurologically complete high cervical lesions, the criteria of inclusion for subjects participating in the project has been slightly modified. Now patients with complete neurological deficit, irrespective of cervical level of lesion, may be included. In addition, those who have complete motor and incomplete sensory lesions may be included. Finally, those who have some sensory sparing with a nonfunctional motor lesion may also be included. The testing procedures have not changed.

APPLICABILITY: It is desirable that tolerance to postural change be achieved during the early physical rehabilitation of patients having lesions of the cervical spinal cord so they may participate in tiltable treatments. Moreover, quadriplegics cannot begin adapting to wheelchair confinement until able to tolerate an upright position. If artificial abdominal support and/or lower limb constriction with an easily achievable effective pressure range can be shown to prevent cardiopulmonary distress and/or reduce energy costs associated with achieving and maintaining an upright posture among quadriplegics, their initial rehabilitation will be facilitated.

239 Didronel in the Prevention of Heterotopic Ossification Following Spinal Cord Injury - Determination of an Optimal Treatment Schedule

Principal Investigator: Samuel L. Slaver, M.D.
Status: New
Cost: Annual \$17,742 Projected Total \$104,085
RT Annual \$ 16,742 RT % of Annual Total 94%
Annual Report Reference: New Project - will be reported
in RT-19 Annual Report #14.

OBJECTIVES

1. To determine the optimal time-after-injury Didronel therapy should be instituted for maximal prophylactic effect.
2. To determine the optimal duration of Didronel therapy for maximal prophylactic effect.
3. To establish dosage-administration recommendations for Didronel which will yield the maximal prophylactic effect.
4. To disseminate project related findings.

METHODOLOGY: One hundred fifty (150) SCI patients who are admitted to the Regional SCI System between and 0 and 12 days after injury, whose lesions are neurologically complete (or incomplete with residual function less than a classification of motor-nonfunctional), who are at least 16 years of age and who are not pregnant will comprise the study sample. These patients will be subcategorized into early and late treatment groups and further divided into three and six month administration groups. X-ray films of both hips will be obtained one day prior to initiation of Didronel therapy, at the end of each treatment period and at one year post injury.

FINDINGS TO DATE: This project has only recently been initiated and no findings are available at present.

APPLICABILITY: The high incidence of heterotopic ossification following spinal cord injury and other severe neurological injury or disease suggests it is a frequent complication found in patients who are admitted for rehabilitation programs. When the heterotopic ossification is of such severity that it limits joint motion and increases or complicates the disability, impaired function may be of such degree that it limits ambulation or wheelchair independence and may even impair a patient's mobility to the extent that he/she must remain bedfast. Protracted periods of confinement in bed or abnormal sitting postures in wheelchairs may result in pressure areas and cause the formation of pressure ulcers.

In clinical studies, Didronel has been shown to be effective in preventing heterotopic ossification when given prophylactically after spinal cord injury.

Since heterotopic ossification frequently leads to extensive and costly hospitalization as well as an interruption of the vocational rehabilitation process it is warranted to pursue studies which directly impact on prevention rather than studying complications once they have occurred.

240 A Voice Operated Response Unit (VORU) to be used in the Psychological Assessment of Motor Impaired Subjects

Principal Investigators: James Rogers, Chief
Biomedical Electronics Section
J. Scott Richards, Ph.D.
Status: New
Dates: June 1979-June 1981
Cost: Annual \$25,516 Projected Total \$53,073
RT Annual \$24,016 RT % of Annual Total 94%
Annual Report Reference: New Project - will be reported
in RT-19 Annual Report #14.

OBJECTIVES:

1. To develop a Voice Operated Response Unit based on commercially available micro-computer components which will allow persons with impaired hand function to be administered a psychological test originally designed to be taken using paper and pencil.
2. To determine whether a voice-operated mode of responding to the MMPI creates an intrinsic bias.

METHODOLOGY: The electronic components required for configuring the Voice Operated Response Unit (VORU) will be selected, acquired, assembled and configured into a working prototype which will be tested for proper operation. Software (computer programs) for controlling the VORU system will be developed. Test items will be entered into the micro-computer and stored on magnetic disc. The reliability of the system will be tested. An Operators Manual and Patient Instruction Program will be written. The MMPI will be administered to a group of volunteers using the standard booklet format and voice operated mode. MMPI profiles will be tallied for each subject following each testing sequence. T-scores for all basic clinical and validity scales will be determined and analyzed.

FINDINGS TO DATE: This project has only recently been initiated and no findings are available at present.

APPLICABILITY: There is increasing interest in the psychological impact of spinal cord injury and other disabling conditions. Psychological tests, in conjunction with a clinical interview, are the primary tools available to rehabilitation psychologists for delineating the interaction between personality and disability. Because most psychological tests require use of the hands, there are numerous occasions in which psychological testing might be indicated but cannot be obtained. The proposed project, then, should be of interest to rehabilitation psychologists, in general, for the following reasons:

1. It will demonstrate the technology for administering the MMPI to patients for whom this instrument would be otherwise inappropriate;
2. It will demonstrate the cost-effectiveness of applying existing technology to clinical problems and settings;
3. It will create new MMPI-related research possibilities which heretofore did not exist; and
4. The technology, while designed, specifically, for MMPI administration, can readily be adapted for use with other kinds of psychological and vocational evaluation instruments whose use would otherwise be restricted.

241 Prescriptive Arm Ergometry to Optimize Muscular Endurance in Spinal Cord Injury Patients

Principal Investigators:	C.T. Huang, M.D. K.V. Kuhlmeier, Ph.D.
Status:	New
Dates:	June 1979-June 1981
Cost:	Annual \$48,196 RT Annual \$45,596
	Projected Total \$96,338 RT % of Annual Total 95%
Annual Report Reference:	New Project - will be reported in RT-19 Annual Report #14.

OBJECTIVES:

1. To determine the heart rate oxygen consumption relationship and mechanical efficiency in untrained paraplegics, quadriplegics and normals using graded arm ergometry and standard regression analysis.
2. To determine whether heart rate levels, optimal for increasing cardiovascular fitness in spinal cord injury patients, are best achieved during continuous, intermittent or progressive work bouts.

3. To determine whether work levels optimal for increasing skeletal muscle endurance in spinal cord injured patients are best achieved during continuous, intermittent or progressive work bouts.
4. To determine whether muscular endurance can be more rapidly and easily enhanced during an individualized prescriptive physical therapy program than during a conventional (nonprescriptive) physical therapy program.
5. To measure heart rates and estimate oxygen consumption from an individual's heart rate oxygen consumption relationship during standard physical exercise bouts to determine work levels achieved.

METHODOLOGY: Maximal work capacity for 30 SCI patients (10 with cervical lesions, 10 with upper thoracic lesions and 10 with lower thoracic lesions as well as 10 normals will be determined by measuring heart rates during arm ergometry. All SCI patients will have neurologically complete lesions. The heart rate increment between resting levels and maximal levels will be determined. Each subject will perform work at a rate expected to elicit a heart rate of 70% of maximal for 10 minutes. Work will also be performed at faster and progressive rates. The maximal heart rate will then be determined for patients selected to participate in a personalized physical therapy program. Finally, the validity of predicting oxygen consumption from heart rate data will be determined.

FINDINGS TO DATE: This project has only recently been initiated and no findings are available at present.

APPLICABILITY: It is desirable that adaptation to physical therapy programs be achieved during the early physical rehabilitation of patients having spinal cord injury, so they may participate in a personalized exercise program without creating undue fatigue or the possibility of a cardiopulmonary collapse. Ideally, the early physical therapy program should be accomplished with minimal energy expenditure since SCI patients are known to experience a marked metabolic depression and deviation from "normal" metabolism after injury.

In this study, the effect of three different exercise programs will be examined. The average work load which can be tolerated and endurance based on the patient's level and extent of injury will be identified. If an objective basis for prescribing physical therapy activities can be determined, it will be possible for many SCI patients to realize their maximum physical strength and endurance capability without untoward energy expenditure in the shortest time possible.

242 Assessing the Need for Post-Discharge Psycho-Social Services for the Spinal Cord Injury Patient

Principal Investigator:	J. Scott Richards, Ph.D.	
Status:	New	
Dates:	July 1979-July 1982	
Cost:	Annual \$23,517 RT Annual \$20,317	Projected Total \$76,345 RT % of Annual Total 86%
Annual Report Reference:	New Project - will be reported in RT-19 Annual Report #14.	

OBJECTIVES:

1. To develop an instrument which will validly assess post-discharge psychological adjustment of the spinal cord injury patient.
2. To determine whether psycho-social problems exist in recently discharged spinal cord injury patients and if so identified, determine whether these problems change or shift in importance during the first post-discharge year.
3. To determine whether spinal cord injury patients or their families seek professional assistance for problems identified in Objective 2 and if they do not, for what reasons.

METHODOLOGY: A model of the psychological adjustment process to SCI will be formulated. An

instrument (designed to be administered by an interviewer) consisting of a self-report component and a behavioral assessment component, will be developed to assess post-hospital adjustment to SCI. This instrument will be pilot-tested and, if needed, revised. The final instrument will be administered to 30 paraplegics and 30 quadriplegics within the first week following discharge, three months following discharge and one year after discharge. It will also be administered to 30 controls. The data will be analyzed and disseminated.

FINDINGS TO DATE: This project has only recently been initiated and no findings are available at present.

APPLICABILITY: Clinical experience suggests that adjustment to spinal cord injury can be a long and arduous process for both patient and family. A substantial portion of this process may occur after the patient is released from the rehabilitation hospital, which frequently coincides with the time the patient and family, of necessity, has lost the close professional contact they previously enjoyed with the multi-disciplinary rehabilitation team. Clearly, some patients, perhaps the majority, can make the transition from inpatient rehabilitation status to independent living without experiencing marked intrapersonal and familial distress. However, clinical experience would suggest there are certainly many others for whom the adjustment process is extremely tempestuous and prolonged, perhaps indefinitely so.

What this suggests is that an undetermined percentage of spinal cord injury patients and their immediate families experience psychological adjustment difficulties following discharge, of such profound dimensions as to require professional intervention. This is the time when the rehabilitation psychologist is typically least able to offer in-depth support because of geographic constraints, prohibitive inpatient demands, etc. The extent to which spinal cord injury patients seek out mental health or other social support services in the local community is unknown. For those who desire and/or could benefit from such services, a variety of factors may interfere with their initiation: architectural barriers, geographical constraints, transportation problems, "mental illness" stigma, etc. If the resistance to inpatient involvement with the rehabilitation psychologist or psychiatrist is an indicator, the problem of "mental illness" stigma may be the most significant barrier to the initiation of mental health service contact by the spinal cord injury patient who has returned to the pre-morbid setting.

243 Physiology of Vowel Production by Normal and Deaf Speakers

Principal Investigator:	Samuel G. Fletcher, Ph.D.	
Status:	New	
Dates:	September 1979-September 1981	
Cost:	Annual \$32,219 RT Annual \$25,248	Projected Total \$64,370 RT % of Annual Total 78%
Annual Report Reference:	New Project - will be reported in RT-19 Annual Report #14.	

OBJECTIVES:

1. To select two groups of deaf speakers with "good" and "poor" speech intelligibility.
2. To obtain listener response device and custom fitted devices for data collection.
3. To develop software program modules for acquiring data and producing a variety of graphic displays.
4. To collect a set of ten vowels in each of six consonant environments from each subject.
5. To conduct perceptual and acoustical evaluations of the vowel in the "words" spoken.
6. To generate a physiological description of the vowel spoken.
7. To analyze vowel-consonant coarticulation to identify patterns of motion to and from the vowels which appear to facilitate joint intelligibility of the sounds spoken.
8. To use factor analytic procedures to produce a mathematical model which identifies central features of tongue, lip and jaw actions of vowel articulation and use this abstraction to consider

phonetic strategies that appear to underlie successful and unsuccessful speech production patterns.

METHODOLOGY: The sample will be comprised of 30 young adult deaf persons. A recording of the utterances of 50 phonemically balanced (PB) words will be obtained and scored for intelligibility. Then five speakers with good and five with poor intelligibility will be chosen. A device will be built for listeners to identify vowels perceived.

The consonant sounds /p, t, k, f, s/ have been selected to use in standardizing vowel production patterns, while the vowels will include /i, z, ez, E, ea, o, au/. Fifteen repetitions of each vowel in each consonant environment will be collected during each of six sessions. The pattern of consonant-vowel-consonant characteristics will be analyzed. Patterns of coarticulation that appear to facilitate or inhibit accurate sound production will be identified, and a mathematical model will be produced to isolate and identify specific physiological parameters which account for the major sources of variation in the vowel spoken.

FINDINGS TO DATE: This project has only recently been initiated and no findings are available at present.

APPLICABILITY: Studies have shown that, on average, speech intelligibility achieved by severely to profoundly hearing impaired children is in the range of 20 to 30%. It deteriorates further in adulthood when the school environment is left. Such poor intelligibility renders the speech virtually non-functional in most work and social settings.

Experimental work has identified vowel distortions as a major source of listener errors in deaf speech. Acoustic disturbances have been identified in both the positions and transitions of the vowel formants.

The research will be used to test the hypothesis of restricted tongue positions and reduced consonant-vowel transitions postulated from prior acoustical studies. It will also be used to increase the effectiveness of treatment routines currently being developed to guide deaf speakers in improving speech production.



**Northwestern University (RT-20)
Medical Rehabilitation Research and Training Center**

CORE AREAS

Neuromuscular Studies Unit

To improve clinical management of neuromuscular dysfunction through development of advanced techniques in diagnosis and understanding of cause and control of neuro motor disturbance.

Rehabilitation Services Evaluation Unit

Improving management and delivery of rehabilitation services through evaluative feedback of programs, procedures and devices constituting the rehabilitative process.

Spinal Cord Injury Rehabilitation Studies

To develop new knowledge in the prevention of medical complications, the maximization of physical and psychologic function, resocialization and vocational achievement of the spinal cord injured.

Behavioral Studies Unit

To improve human performance of the physically disabled through new understanding of the behavior of the disabled individual, significant others and the providers of rehabilitative assistance.

NORTHWESTERN UNIVERSITY

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COMPLETED

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244 Conceptual Model of Planning and Evaluation of Rehabilitation Services

Principal Investigator: S. Horasymiw, Ph.D.
Status: Completed
Dates: August 1978-September 1978
Cost: Annual - N/A Projected Total \$77,321
.../ Annual - N/A RT % of Annual Total - N/A
Annual Report Reference: #12, Page 24, B-39

OBJECTIVES:

1. To develop and refine a theoretical model that incorporates the parameters of time scale, life function scale, agents involved in the process of rehabilitation, disability conditions.
2. Develop a set of standardized scales and/or indicators measuring relevant life functions (e.g., mobility, self care, work adjustment) to measure changes that occur during the process of rehabilitation.
3. Develop a computer based simulation system that would incorporate the various components of the model to test and evaluate its practicality.
4. Based on the conceptual model and its simulation system by computer a model for planning, management and evaluation of rehabilitative services would be built and machine generated cost and life function indicators would be developed to serve as aids in the planning, delivery and evaluation of rehabilitation services.
5. Develop and maintain a computer accessible standardized data base on four disability groups that will provide the "real world" base for the model as well as serve various empirical investigations.
6. Based on normative information, modes of rehabilitation derived from the model would be presented. Data base analysis and evaluation of the rehabilitative process from a cost benefit and cost effectiveness modes would be made and alternative modes of rehabilitation would be presented.

METHODOLOGY: The individual project components follow:

1. Structuring of the theory.
2. Modification of life function scales.
3. Empirical data collection.
4. Data Normalization.
5. Development of prototype simulation model (trajectory and parameters).
6. Development of four disability comparisons model (trajectory and disabilities).
7. Development of a rehabilitation agency and activities simulation model (trajectory X disability X agents-agencies).
8. Development of an integrated systems approach.

FINDINGS TO DATE: The primary goal of this project has been to develop a comprehensive rehabilitation process model which would provide vital patient care, outcome and cost data; integrate it into a multi-disciplinary/dimensional structure and develop a computer simulation model for examining the process theoretically as well as empirically. The data base consists of some 5,000 medical rehabilitation inpatients with varying disability types. These data are also integrated with various outpatient and post-hospitalization follow-up or outcome studies.

Specific uses of the model to date include:

1. Preliminary cost-benefit analysis of comprehensive medical rehabilitation;
2. Prediction of vocational potential and readiness of the disabled;

3. Prediction of physical function and social outcome of the disabled; and
4. Modeling the dynamics of patient-therapist treatment interaction.

In addition to the preceding applications those for the future include analysis of multiple or integrative service (e.g., P.T. and O.T.) impact on patient functional outcome; network linkage with other agency or hospital data systems and development of a regional or national "disability registry" of incidence/prevalence and critical characteristics.

APPLICABILITY: Facility Management. The demand for cost efficient operations requires management structures where alternate decisions have a best fit in a given budget. A theoretical service model grounded by an empirical data base and designed for machine simulation would facilitate management of rehabilitation systems.

Teaching. From the standpoint of teaching rehabilitation science, a theoretical model of rehabilitation is needed to facilitate conceptualization of the rehabilitative process and to illustrate and interrelate such concepts as prevention, trauma, rehabilitation, habilitation, exceptionality and process monitoring, recovery curves, trauma and decreased efficiency curves, functional efficiency profiles, systemic interrelationships and normalizations of curves for handicapped and non-handicapped populations.

Research. On the basis of the theoretical model, programmatic research could be conducted more efficiently because model simulation would be based on theoretically and empirically derived environmental inputs, empirical grounding and heuristics. By means of the model a set of recovery rates with alternate rehabilitative environments, different disability groups and different agents operating on the disabilities could be simulated and compared with practice in the "real world" environment for more effective research problem solving.

Patient-client Management. In patient-client management environment, (e.g., physical therapy, rehabilitation counseling) knowing the types of differential probabilities of success for given individuals, disabilities, and rehabilitation methods would facilitate the selection of alternatives providing the most successful outcomes.

245 Prevention of Urinary Tract Infection in Spinal Cord Injury

Principal Investigator:	Y. Wu, M.D.	
Status:	Completed	
Dates:	April 1976-September 1978	
Cost:	Annual - N/A RT Annual - N/A	Projected Total \$39,901 RT % of Annual Total - N/A
Annual Report Reference:	#12, Page 53, R-46	

OBJECTIVES: This project is divided into two major objectives:

1. Evaluation of the dynamic mechanism of the bladder against infection.
2. Development and evaluation of devices which facilitate bladder infection prevention and/or management.

METHODOLOGY:

1. Evaluation of dynamic defense mechanism of bladder against infection. Conform CURDT formula in vivo in spinal cord injured subjects with neurogenic bladder.
 - a. Measurement of post-catherization residual urine volume.
 - b. Evaluation of bacterial doubling time in bladder. Determine effect on bacterial doubling time of anti-bacterial agents.

2. Development and evaluation of devices which facilitate bladder infection prevention and/or management.
 - a. Clinical evaluation of RIC catheter kit.
 - b. Develop and evaluate home monitoring system for bacteriuria.
 - c. Develop and evaluate home catheter sterilization procedure.

FINDINGS TO DATE:

1. **In vivo bacterial doubling time determination.** In order to confirm that the defense mechanism formula works it was first necessary to determine the one unknown and difficult to measure variable, bacterial doubling time, D. this was accomplished and determined that the common uro-pathogens have growth doubling rates of about 20 to 70 minutes in spinal cord injured humans with bladder infections and that the formula does simulate clinical findings.
2. **Application of the bladder defense mechanism formula to clinical management of bladder infection.** The defense mechanism formula can be converted to a simple two dimensional graph, called the RIC Bladder Graph, and from this a "safe emptying interval" can be determined which indicates how frequently in a given patient the bladder should be emptied in order to prevent the growth of significant numbers of bacteria. This is the major practical application of the project findings.
3. **Effect of antibacterial and urine-acidifying agents on bacterial doubling time.** By measuring bacterial doubling time in vivo and in vitro it has been possible to determine preliminarily how effective such ingested drugs as ascorbic acid, mendeamine, or sepra and such bladder-instilled agents as acetic acid may be in reducing the rate of growth of bacteria in the bladder urine. One set of implications of this is that more effective and safer agents and procedures can be employed to prevent or manage neurogenic bladder infections when used in conjunction with the RIC Bladder Graph and dynamic defense mechanism concept.
4. **Evaluation of the new disposable RIC-Wu Catheter Kit.** This innovative catheter kit permits fast, simple, sterile, non-touch bladder catheterization by hospital staff or patients themselves at reduced cost. The device was developed at RIC by Dr. Wu and it has been commercially produced and marketed to hospitals in the United States and Canada. Over 250,000 catheters have been distributed since late 1977.
5. **Development and evaluation of a reusable (home) catheter sterilization procedure.** A simple reusable catheter has been developed by Dr. Wu which facilitates long-term intermittent catheterization by patients at one-tenth the cost of current disposable catheters. A simple, effective procedure to sterilize this catheter at home has been developed.
6. **Development and evaluation of a patient home monitoring system for detecting bacteriuria.** Similar to the principle of diabetic patient monitoring of sugar or acetone in the urine, a "dip slide" procedure for detecting significant bacteriuria by the spinal cord injured person at home has been preliminarily developed. Further development of this procedure is the focus of another project.

APPLICABILITY: The possible procedure changes could be:

1. Shift from use of current expensive and inconvenient catheter set to RIC Catheter Kit. (The Illinois Tool works has applied for a patent for the RIC-Wu Catheter Kit and has been marketing it nationally since early in 1977.)
2. Routine determination of bacterial doubling time and use of bladder emptying frequency chart in bladder management.
3. Broader use (or non-use) of bladder additives to prolong bacterial doubling time.
4. Method of home sterilization of the intermittent catheter.
5. Method of home-determination of urine sterility.

246 Therapeutic Recreation Outcome

Principal Investigator:	L. Carpino, M.A.	
Status:	Completed	
Dates:	October 1978-September 1979	
Cost:	Annual \$39,259 RT Annual \$34,971	Projected Total \$39,259 RT % of Annual Total 89%
Annual Report Reference:	#12, Page 97, R-72	

OBJECTIVES:

1. To examine the type and degree of patient participation in therapeutic recreation activities and to develop a scaled measure of this participation.
2. To develop an index of social adjustment which will reflect patient functional performance in the physical and social environment considered relevant to therapeutic recreation expected outcomes.
3. To determine if there are inter-relationships between type and frequency of participation in therapeutic recreation activities and patient functional performance during and following rehabilitation.
4. To determine the cost of rehabilitation intervention in general and participation in therapeutic recreation in particular and determine the relationships between costs and adjustment outcomes.
5. To identify formal therapeutic recreation follow-up procedures for patients leaving the rehabilitation setting that will optimize social and recreational achievement by the disabled in the community.

METHODOLOGY: The study population consists of 650 subjects, divided into cross-sectional and longitudinal groups. The cross-sectional sample consists of 500 first admission inpatients whose therapeutic recreation (TR) participation records were coded and entered into the Rehabilitation Information System (REHABIS). The longitudinal population, consisting of 145 subjects, were interviewed at hospital admission to determine their premorbid leisure activities, and at one month post discharge. This data was subsequently merged into the REHABIS system. One year post discharge interviews are now being completed on this sample to determine leisure activity patterns and activities of daily living functioning.

FINDINGS TO DATE: Initial analysis of the data took the form of a path analysis of the spinal cord injured (SCI) segment (N=52) of the longitudinal sample. Preliminary findings indicate that those spinal cord injured who had higher premorbid involvement in sports, games and social activities showed greater participation in therapeutic recreation activities. In addition, the level of functional ability at admission does not seem to promote or hinder participation in TR activities.

APPLICABILITY: The information generated from this study will be used principally in the planning of recreation programs in clinical rehabilitation settings. Community recreation managers will also find a use for this information in their programs for the physically disabled.

Policy change implications include third-party payments for follow-up services as an integral component of comprehensive medical rehabilitation.

247 Idiopathic Scoliosis: Structural, Ultrastructural and Chemical Pathology of Paraspinal Muscles* Formerly: Ultrastructure of Muscle in Idiopathic Scoliosis

Principal Investigator: V. Sahgal, M.D.
Status: Completed
Dates: October 1978-September 1980**
Cost: Annual \$21,246 Projected Total \$58,164
RT Annual \$16,339 RT % of Annual Total 77%
Annual Report Reference: #12, Page 107, R-98A

*Project R-98 and R-98A have been combined and the title changed accordingly.

**A one year extension is requested to 9/30/80.

OBJECTIVES: It was decided to study the paravertebral muscles at the apex of the curve on either side of curvature (i.e., concave and convex). It was thought that a biopsy taken from the gluteus maximus would act as a suitable control muscle and, therefore, was included in the histochemical, morphometric and electron microscopic studies.

The questions asked in the investigation are:

1. Is there a "side-related" pathology in paraspinal muscles?
2. Can gluteus muscle be taken as an "unaffected" region?
3. What is the nature of abnormality?
4. Is there any significant difference in quantitative distribution of cell organelles?

METHODOLOGY: The studies carried out on biopsy specimens are done in depth and include:

1. Morphology with standard haematoxylin and eosin, modified Gomori's trichrome and other stains. Enzyme histochemistry to detect myofibrillary ATPase, DPNH and phosphorylase activity which would differentiate fiber types having oxidative and glycolytic metabolism.
2. Histograms are made depicting the distribution and the number of Type I and Type II fibers for three regions in each biopsy (i.e., gluteus maximus, concave and convex apex). Mean fiber size diameter is also calculated for each fiber type in each region of paraspinal muscle.
3. Electron microscopic studies of all three kinds of muscles (gluteus maximus, concave apex and convex apex) for each biopsy.
4. Morphometric studies on electronmicrographs as described in detail in the report on chronic renal disease by Loud's method (1962).

Methods of muscle biopsy, histochemistry and morphometrics have been described in earlier Project PR-98. Routine EM processing and EM quantitative methods have been described in RT-20 Report #10, Project R-98A.

FINDINGS TO DATE: In this project six cases of "idiopathic scoliosis" have been carefully analyzed. Histochemical ATPase activity and morphometric studies on Paraspinal and non-spinal muscle reveal Type II atrophy and unusual 2:1 ratio of Type I to Type II fibers. Pathological changes were not confined to the muscles in the spine region but were also found in gluteus muscle of the buttocks. Ultrastructural study showed the presence of abnormal nemaline rods in two biopsies. Other changes included lipid and glycogen in the subsarcolemmal region. Ultrastructural quantitative studies of cellular organelles in four biopsies indicated high variations in the distribution of mitochondria, glycogen, lipid, etc., in various biopsies. The latter work is still in a preliminary stage and promises to be very useful when extended.

APPLICABILITY: Scoliosis is rather common (approximately 210/100,000 total population or about 460,000 new cases per year in the United States) and is severely disabling in a significant percentage of these; work time loss is about 20 times that of a normal person and marriage frequency is only 25 percent of normal.

Considerable time and effort (hence, cost) by orthopaedic surgeon, orthotist and physical therapist are involved in management of this disabling condition during the adult as well as childhood and adolescent periods.

The relevance of this project to rehabilitation medicine is that by having an understanding of the morphological and biochemical events involved in idiopathic scoliosis a rational basis for treatment of humans afflicted can be established. **The reduction of disability which accompanies scoliosis can significantly improve independent function and work capacity.**

248 Patterns of Sensory Integrative Dysfunction in Adult Hemiplegia

Principal Investigator:	C. Chapparo, O.T.P.	
Status:	Completed	
Dates:	October 1978-September 1979	
Cost:	Annual \$15,632 RT Annual \$14,253	Projected Total \$15,632 RT % of Annual Total 91%
Annual Report Reference:	#12, Page 131, R-112	

OBJECTIVES: Previously, therapists at the Rehabilitation Institute of Chicago have not been equipped with one evaluation instrument which is specifically designed to identify types and patterns of existing sensory integrative dysfunction involving the variety of sensory systems affected by stroke. A tool, the Sensory Integration Test Battery, has been developed at the Rehabilitation Institute to aid occupational therapists in particular in determining such sensory integrative problems and their effect on functional ability.

It is the intent of the investigators that this be a pilot study, attempting to measure cluster or patterns of sensory integrative dysfunction and their relationship to functional ability in adult hemiplegia.

The main objectives of this project are:

1. To identify patterns of sensory integrative dysfunction in adult hemiplegia secondary to cerebral vascular accident.
2. To determine if there is an existing relationship between specific patterns of sensory integrative dysfunction and functional ability.
3. To determine if there is an existing relationship between types of sensory integrative dysfunction, psychometric status, types of speech and language dysfunction and neurological status.
4. To determine the effectiveness of the Sensory Integrative Test Battery for Adult Hemiplegia in identifying deficits in processing sensory information.

METHODOLOGY: A sample of 80 patients between the ages of 50 and 69 years with a diagnosis of hemiplegia secondary to cerebral vascular accident who are under the care of the Rehabilitation Institute attending physicians will be tested. Cluster analysis will be computed on scores obtained from the Sensory Integration Test Battery to determine existing patterns of dysfunction. In addition, these scores will be compared with scores obtained from a functional abilities profile and supplemental speech language and psychology information retrieved through REHABIS (computerized rehabilitation information system at RIC). A neurological screening exam will be performed by a neurologist to verify diagnosis and to clinically localize the lesion site.

FINDINGS TO DATE: At this time the Sensory Integration Test Battery has been refined after preliminary use, the neurological screening form has been developed and testing is underway. Limited data obtained thus far seems to indicate that the Sensory Integration Test Battery is sensitive in determining multiple sensory processing problems, and that a demonstrable relationship does exist between patterns of dysfunction and functional ability.

APPLICABILITY: It is proposed that the occupational therapists at the Rehabilitation Institute of Chicago will be able to utilize these results in developing a more standard way to evaluate adult hemiplegia.

Principal Investigator:	V. Sahgal, M.D.	
Status:	Completed	
Dates:	October 1978-September 1980*	
Cost:	Annual \$35,642 RT Annual \$11,057	Projected Total \$56,710 RT % of Annual Total 31%
Annual Report Reference:	#12, Page 149, R-113	
*Twelve month extension requested to 9/30/80.		

OBJECTIVES: The following questions were primarily asked:

1. What is the nature of the morphological or structural changes observed in the biopsy? (Pathological changes in muscle biopsies or needle biopsies of muscle as seen by histological staining of frozen material (routine M&E and modified Trichrome)).
2. How are the different fiber types affected when seen on the basis of glycolytic or oxidative enzyme staining? (Differentiation of fiber types as seen by histochemical enzyme staining - Myofibrillar ATPase pH 4.4 and 9.4, NADH activity).
3. Is there any unusual storage of metabolic product or accumulation of other organelles in a cell? (Study of the glycogen and lipid content in different fiber types by special staining methods).
4. Is there any quantitative significance as regards to fiber size and the fiber type? (Histometric analysis to determine the distribution of 2 types of fibers with respect to fiber diameter).
5. What organelles in a fiber are especially affected at subcellular level? (Ultrastructural alterations as seen by EM).
6. EM stereology - to quantitatively determine the distribution of various cellular organelles in these biopsies.

METHODOLOGY: All patients will be disabled by end stage renal disease and maintained by dialysis; most will be male; age 30-70. Further description of characteristics must await selection of patients for the study. Histochemical methods, fiber size measurement as well as EM routine preparative methods were described in the project proposal. However, Loud's methods of EM quantitative study in the above referenced report under EM Stereology.

FINDINGS TO DATE: Various neuromuscular related complications (e.g., weakness) are encountered in patients in dialysis or suffering from chronic renal disorders. No systematic histochemical, ultrastructural and quantitative studies of muscle biopsies from these kinds of patients have been carried out to provide a basis for understanding the mechanisms leading to the complications. This report describes quantitative histochemical studies and histogram analysis at the light microscopic level and at the ultrastructural level on muscle biopsies obtained from patients as long term renal dialysis. Three biopsies clearly indicate Type II muscle atrophy while non-specific myopathic changes such as variation in fiber size, central nuclei, fiber splitting were observed in all cases. At the ultrastructural level, Z band spreading, presence of nemaline-like rods were seen in two cases. Subsarcolemmal regions studied for EM quantitative work by Loud's method (1962) revealed high variation in subcellular organelles such as lipid, mitochondria, glycogen, etc., in different biopsies. The pathological picture emerging from this sample size is certainly interesting but requires a larger sample size to have statistically meaningful inference.

APPLICABILITY: A long survival of patients with end stage renal disease implies a productive capacity during much or most of that survival period. When work performance is diminished or prevented altogether by a complication resulting from treatment of the disease itself it is essential that efforts be made to prevent or control the complication. Muscle weakness in end stage renal disease does reduce work capacity and contribute to the high unemployment rate of these disabled people. Understanding first where the impairment is in the neuromotor machinery and then finding its cause is the rational path being followed to prevent and control this particular disabling consequence of end stage renal disease.

Therapists at this institution view this instrument as a beginning tool to reliably measure change from admission to discharge. In this way, therapists can begin to measure effectiveness of treatment techniques utilized.

If, after further investigation, the test instrument developed proves reliable and valid, support for the use of this method of evaluation will be sought through the American Occupational Therapy Association.

250 Vocational Follow-Up of the Physically Restored Unemployed Spinal Cord Injured

Principal Investigator:	S. Harasymiw, Ph.D.	
Status:	Continuing	
Dates:	April 1978-September 1978	
Cost:	Annual \$24,047 RT Annual \$21,423	Projected Total \$84,713 RT % of Annual Total 89%
Annual Report Reference:	#12, Page 45, R-45B	

OBJECTIVES:

1. To establish a systematic vocational rehabilitation follow-up program for the spinal cord injured RIC inpatient population.
2. To validate the Job Potential Readiness Scale, a predictor instrument, which will assist the vocational counselor with preliminary screening of those patients who may be ready for a vocational program.
3. To demonstrate effectiveness and cost of such a systematic vocational follow-up program.

METHODOLOGY: The purpose of this project is to increase vocational placement of severely disabled, physically restored who are unemployed (PRU), by use and demonstration of a pre-planned vocational service follow-up program.

Pilot project R-45A demonstrated preliminary feasibility and operating procedures for such a program. This present definitive project will prospectively demonstrate the effectiveness of the program.

Current systematic application of earlier identified follow-up procedures as well as advanced development of a vocational predictive instrument, the Job Potential Readiness Scale (JPRS), should result in increased frequency, speed, and duration of vocational placement of the spinal cord injured.

The subjects will consist of former and prospective RIC patients discharged between January 1978 and June 1980 whose cases are considered closed (e.g., physically restored but unemployed) by the Vocational Rehabilitation Department at RIC. Additional criteria for sample selection are clients discharged from RIC who are in the labor market (not students, housewives or rehired), and clients residing in the 312 telephone area code region.

The study population will be divided into two samples, cross-sectional and longitudinal. The cross-sectional group will be composed of 300 subjects. The longitudinal group will be composed of a sample of 100 SCI patients discharged from RIC during the project period. These subjects will be administered the JPRS at five points in time: 3, 6, 12, 18 and 24 months post discharge.

Rehabilitation data (medical and functional status, degree of disability, recidivism, costing information, activities of living functioning, etc.) will be monitored as retrieved from the computerized data bases, MRSCICS and REHABIS (MRSCICS is the Midwest Regional Spinal Cord Injury Care System and REHABIS is the Rehabilitation Information System of the Rehabilitation Institute of Chicago).

FINDINGS TO DATE: The achievements to date include 94 completed JPRS longitudinal interviews which comprise a total active follow-up sample of 65 discharged rehabilitated RIC inpatients currently

being monitored for possible vocational rehabilitation intervention. A separate cross-sectional sample utilized for JPRS development and validation includes 118 clients to date.

Findings will not be available until 1981.

APPLICABILITY: Not Specified

251 Post Rehabilitation Problems and Costs

Principal Investigator: S. Harasymiw, Ph.D.
Status: Continuing
Dates: April 1977-September 1979*
Cost: Annual \$48,534 Projected Total \$111,258
RT Annual \$32,845 RT % of Annual Total 68%
Annual Report Reference: #12, Page 84, R-60

*A six month extension to 9/30/79 is requested at no additional federal expense.

OBJECTIVES: The overall purpose of this project is to study severely disabled individuals during the rehabilitation post-discharge period to determine why some patients are maintaining successful adjustments while others require multiple hospital readmissions. The specific objectives are:

1. to obtain an accurate knowledge (type and rate) for each major disability of follow-up stresses and complications in medicine, mobility, self-care, work adjustment and performance, involvement with family and significant others;
2. to identify ways that patients have adjusted to problems arising post-discharge and identify techniques that can prevent complications and facilitate adjustment in other patients; and
3. to compare the needs, costs and recovery stages of the disabled who have gone through rehabilitation on first admittance and those of patients who have had several readmissions.

METHODOLOGY: The subjects for this study will consist of 320 randomly selected RIC patients discharged in 1976, 1977 and 1978. Dichotomous classification will be made in terms of patients who are **first admits** and **readmits**, regardless of the reason for readmittance. Patients will be categorized under the major categories of spinal cord injured, focal cerebral and "other."

The instruments for data collection are specially designed questionnaires to be administered through telephone and personal interviews.

Initial patient functional performance data at admission and at discharge will be taken from the Rehabilitation Information System (REHABIS) for patients discharged in 1976, 1977 and 1978. The information consists of demographic data, type and extent of impairment, type and extent of disability, type, amount and cost of services provided. REHABIS also has the capacity to input post-discharge follow-up data relevant to continuing handicapping conditions, vocational placement or extent of independent living and the amount and cost of continuing services. Home visits are also being made by research staff in instances where data is not otherwise available.

FINDINGS TO DATE: The project is currently in a six-month extension phase to analyze, implement, and disseminate the information to potential users.

Initial analysis on a selected sample of patients shows a statistically significant relationship when costs are grouped into single, double and multiple hospitalizations.

In terms of support services received up to the time of the six month interview, some 70% of the patients had accessed physician services. Physical therapy and nursing services were utilized by 50% of the sample, with an additional 25% receiving occupational therapy services.

Utilizing the Prognosis Indicator Instrument social workers rated patients on ten adjective scales, indicating the likelihood that the patient would develop problems in four major topical areas: estimating also the probability of unplanned readmission for a given patient. A factor analysis of

the ratings for Time 1 and Time 2 were performed to reveal the underlying structure of the staff's judgments. These three factors can be labeled: Potency (F1), Prognosis (F2), and Sociability (F3). All variables are uniquely accounted for, except for the intelligence variable, which seems to be related to all three factors.

These data, when correlated with empirical evidence of patients' readmissions and difficulties with reintegration into the community will provide a solid base for high risk patient identification. Subsequently, more cost-efficient intervention programs may then be established to anticipate problems before they precipitate unnecessary and enduring costs to the individual and society.

APPLICABILITY: It is anticipated that the close involvement of the RIC Social Work Department in the project will facilitate further dissemination and implementation of programmatic changes into the department's service delivery system. If service delivery modifications are implemented in an operating system, a much more efficient model can then be devised.

Policy change implications include third-party payments of follow-up services as an integral component of comprehensive medical rehabilitation. Of specific relevance is the concept of appropriate discharge point and monitoring of patients post-discharge to establish a preventive maintenance linkage with those patients who are specifically identified as high risk.

252 Comparative Study of Sling Supports for the Subluxed Hemiplegic Shoulder

Principal Investigator:	B. Ritt, B.S., O.T.R.	
Status:	Continuing	
Dates:	October 1978-September 1979	
Cost:	Annual \$12,054	Projected Total \$12,054
	RT Annual \$10,958	RT % of Annual Total 91%
Annual Report Reference:	#12, Page 125, R-109	

OBJECTIVES:

1. Design a simple, safe and inexpensive method to accurately and objectively measure subluxation in the hemiplegic shoulder.
2. Develop criteria for adequate fitting of a sling.
3. Compare four major slings used at RIC to determine their effectiveness in reducing subluxation.
4. Determine to what extent normal activity changes the fit of a sling.
5. Establish guidelines for what type of sling to prescribe for the flaccid versus spastic subluxed hemiplegic shoulder.

METHODOLOGY:

Hypotheses:

1. Simple external (skin surface) measurements of the subluxed hemiplegic shoulder correlate with radiological findings in determining: (a) presence of subluxation and (b) degree of subluxation.
2. A correlation exists between extent of subluxation and the degree of elbow flexion in any given subject. (Lever arm forces influence extent of subluxation.)
3. Four types of slings: the Cuff type, Clavicular Strap, Figure 8 and the Shoulder Saddle effectively reduce subluxation of the hemiplegic shoulder in sitting and standing positions: (a) after initial fitting and prior to activity and (b) after activity.
4. The Cuff type sling reduces subluxation in the flaccid hemiplegic shoulder better than the Clavicular Strap, Figure 8 or Shoulder Saddle slings.
5. The Clavicular Strap sling reduces subluxation in the spastic hemiplegic shoulder better than the Cuff type, Figure 8 or Shoulder Saddle slings.

Northwestern University

A total population of 50 persons will be involved in this study. Of these, 10 will be able-bodied persons between the ages of fifty and eighty to serve as method controls. The remaining 40 persons will be chosen from inpatients at RIC. Ten (10) of these 40 persons will have three x-rays and external measurements to confirm extent of subluxation. The remaining 30 patients will have external measurements only and will undergo a prescribed set of activities and measurements using the four test slings.

FINDINGS TO DATE: Seventeen subjects have been measured to date from a proposed population of fifty. Six RIC employee volunteers, age matched to RICs hemiplegic population had shoulders measured externally with plastic jig and internally with x-rays. Quantitative measures of the joint spaces were made. The N was too small to determine correlation between internal/external measures.

Eleven persons with subluxed hemiplegic shoulders were similarly measured with and without sling. Data is presently being analyzed.

APPLICABILITY: The rehabilitation team can use the data collected to more efficiently determine what type of sling, if any, to issue to hemiplegic patients with subluxed shoulders. If the hypotheses are disproved, then the rehabilitation team can further explore alternative methods of treatment. If the data support the hypotheses then guidelines can be established for the most effective sling to issue to hemiplegic patients with flaccid or spastic subluxed shoulders.



**Texas Tech University (RT-21)
Research and Training Center in Mental Retardation**

CORE AREAS

Work Potential of the Retarded

An exploration of the capacities for employment of mentally retarded persons including those not traditionally eligible for vocational rehabilitation services.

Counseling the Mentally Retarded and Improving Service Delivery

Central to this core is the role of the counselor in habilitating mentally retarded client. It has been broadened to include research which evaluates rehabilitation programs toward the end of improving service delivery.

**Research on the Special Needs of the Mentally Retarded
with Multiple Handicaps**

Activities which include special studies of the blind retarded and deaf retarded

Deinstitutionalization and Community Adjustment of the Retarded

Exploring key variables associated with successful community adjustment of the retarded and dealing with social skill training, community attitudes and community based residential facilities.

TEXAS TECH UNIVERSITY

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COMPLETED

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Texas Tech University

PROPOSED

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253 Group Homes for the Mentally Retarded in the Rehabilitation Process

Principal Investigator:	Carol K. Sigelman, Ph.D.	
Status:	Completed	
Dates:	January 1973-December 1978	
Cost:	Annual \$ RT Annual \$	Projected Total \$80,500 RT % of Annual Total
Annual Report Reference:	#8, Page 176, R-14	

OBJECTIVES: The project is a comprehensive inquiry into the nature and effectiveness of group homes for the mentally retarded as environments for personal and social growth essential to vocational success. The research focuses upon three interlocking organisms: the mentally retarded person, the group home as a social system, and the community. Its objectives are (1) to determine critical differences between the institution and the group home as environments for developing social adjustment skills; (2) to determine the interrelationships between group homes and the communities in which they exist, focusing upon integration of the retarded into community life and responses of the community toward group homes and their residents; (3) to identify critical social adjustment problems encountered in group home placements, with an eye toward developing personal-social adjustment training programs designed to correct problems identified; (4) to assess the effects of group home placement upon retarded clients with respect to personal, social, and vocational adjustment; and (5) to relate changes in group home residents to variables in the group home and its community. The study is, in general, designed to further knowledge of the support system and training strategies conducive to optimal social and vocational adjustment.

METHODOLOGY: Institutions, halfway houses, and small group homes have been compared through use of scale of normalization developed and administered to houseparents and residential supervisors, and observational studies were conducted to compare actual activity patterns and supervision styles in small group homes and larger, institutional settings. Interrelationships between group homes and their community settings were assessed through use of a group home survey and an indirect attitude questionnaire designed to measure attitudes in the Lubbock, Texas community. A long-range goal of improving personal-social adjustment training in transitional facilities was approached through a multiple step process to culminate in the development of guidelines and recommendations for adjustment training. Facility logbooks and behavior rating forms were the primary data sources. Where agreements with operating facilities could be made, a checklist of Skills and Knowledge important for Community Adjustment was administered to houseparents at six month intervals for each resident in the facility, supplemented by observation where possible.

FINDINGS TO DATE: A group home survey was completed by almost 50 facilities to yield basic descriptive information. Further information has been collected on each of the major study areas. There were not significant differences with respect to normalization between facilities for the retarded and facilities for the non-retarded. However, analysis of facilities for the mentally retarded indicated that as the number of residents increases, normalization decreases.

Two observational studies have been conducted. The results of one study indicated that leisure behaviors in two group homes were very similar but differed systematically from leisure behaviors in an institutional cottage. The study also indicated that the group homes were characterized by more balance among activity types, particularly by a reduction in the amount of passive leisure and an increase in the amount of household performance. However, the group homes did not seem to be encouraging the kind of goal-oriented, creative leisure which would help the retarded to adjust to independent living. The single most important finding to emerge from the second study was that residential environments differ from one another in complex ways. The study did not uncover differences in staff-resident interaction patterns which would discriminate reliably between group homes and larger, institutional settings.

A study of community attitudes relevant to community placement of retarded adults conducted in Lubbock, Texas, suggested that Lubbock residents lack well-formulated opinions for or against group homes, but are generally somewhat unfavorable. Demographic variables did not go far in

predicting which types of people are most receptive to group homes and legal rights for the retarded.

Staff logbooks have been used as a source of data concerning adjustment problems in four facilities of the halfway house design. Individual problem behavior tends to be consistent over time, and often centered on failures of responsibility. However, individual problem behavior could not be readily predicted on the basis of IQ adaptive behavior, or sex.

A study of personal-social functioning with implications for adjustment in the community developed a method of assessing the job interview skills of the mentally retarded client. Nonverbal behaviors, verbal behaviors, and measured intelligence predicted the favorability of ratings given to interviewees by personnel interviewers.

Analysis of results of studies to establish the utility of the Skills and Knowledge checklist suggested that checklist performance is highly related to IQ score. The checklist discriminated among clients at different levels in a deinstitutionalization program. Reliability was judged minimally adequate.

Analysis of changes in checklist scores for institutionalized and group home samples indicated that institution residents exposed to a community living skills tutoring program improved over a 6-month period as much as group home residents but more than residents of another institution without such a tutoring program.

Overall, the project uncovered many problems in deinstitutionalization and did not support the idea that group homes and halfway houses are always preferable to institutional environments.

APPLICABILITY: Better understanding of the nature and effectiveness of group homes will be immediately useful to vocational rehabilitation agencies currently using or planning to use group homes as a rehabilitative tool. In addition, analysis of social adjustment problems of retarded residents in group homes will expedite analysis of similar problems in other settings. Finally, the study was designed to uncover the types of environmental intervention which produce positive change in personal and social attitudes and behaviors relevant to employability and vocational success.

254 Process and Outcome in Cooperative School Programs in Texas

Principal Investigator:	Carol K. Sigelman, Ph.D.	
Status:	Completed	
Dates:	January 1976-December 1978	
Cost:	Annual \$ RT Annual \$	Projected Total \$38,030 RT % of Annual Total
Annual Report Reference:	#8, Page 52, R-30	

OBJECTIVES: The objectives of this study are: (1) to describe process variables in cooperative school programs (CSPs) in Texas, identifying components of programs which vary from school to school and from client to client; (2) to measure outcomes of cooperative school programs in terms of the client's level of social and vocational information, vocational status at the end of the twelfth grade, and rated adjustment in a vocational placement; and (3) to identify relationships between process and outcome variables which would include that certain program offerings and experiences contribute to client success.

METHODOLOGY: This study represents an attempt to determine which program factors contribute to the effectiveness of cooperative school programs. Its basic design included the following:

1. **Sample Selection:** A list of graduating seniors and a list of their primary disabilities was obtained from each cooperative school program in Texas. To limit the number of programs from which students were sampled and to represent proportionately program variables of possible importance, it was decided to classify the graduate lists on the basis of four relevant variables. Proportionate numbers from each classification were selected to form a representative sample of programs and students in them.
2. **Background Variables:** Data collected consisted primarily of information which was readily

available in the VAC's student/client files or on the rehabilitation agency's central computer file (e.g., ethnic group, secondary handicaps, number of family members).

3. **Process Variables:** The key personnel in the cooperative school program—the Vocational Adjustment Coordinator, Director of Special Education (DIR), the Vocational Rehabilitation Counselor (VRC), and the Rehabilitation Supervisor (SUP)—were asked to complete questionnaires about program characteristics, operation, and offerings. The VAC and VRC also completed another questionnaire pertaining to each individual student in the study. Questionnaires completed for each subject in the study were designed to reveal individual differences in experiences within the context of a general program.
4. **Outcome Variables:** Outcome measures, collected just prior to graduation, consisted of the following: (1) the Social and Prevocational Information Battery, (2) information obtained from vocational rehabilitation case files and from VACs and VRCs concerning income, type and length of job placements, and judgements about current work adjustment and prognosis, and (3) The Worker Rating Form, developed by the R&T Center, and completed by student's employer or work supervisor.

FINDINGS TO DATE: Analysis of open-ended questions concerning the greatest strength in CSPs revealed that a substantial portion of the respondents (30%) felt that smooth and open communication among CSP personnel, regular school staff, administrators and the community was the greatest strength of their CSPs. The next most mentioned strength was VAC competence. Regarding weaknesses, communication again was the most frequently mentioned area, but it was perceived only about half as many times as a program deficit than as a strength. Fifteen percent of the respondents perceived a shortage of on-campus training opportunities as the greatest weakness.

The VAC, VRC, and DIR responded to a rating form asking them to determine whether the performance of various staff roles, including those in special education and rehabilitation, was below, at, or above expectations. While the VRCs rated nearly half of the VACs as performing above expectations, vocational education and regular teacher roles were frequently perceived as below expectations. VAC and DIR ratings of the staff roles were similar to those of the VRC in terms of percentages of roles perceived as being performed below, at, and above expectations.

In order to identify factors which facilitate or inhibit the effectiveness of the CSP, all responding groups completed a scale consisting of items related to program success. Each respondent rated each factor as it related to their CSP on a scale ranging from excellent to very poor. While the overall means for items were high for all rating groups, two factors—curriculum availability and availability of jobs—emerged as relatively weak factors. Correlations performed to assess the extent to which different participants in the same programs agreed in their perceptions of the factors in program effectiveness indicated a moderately high degree of agreement among CSP personnel. Analysis of the individual items, however, indicated that intra-agency agreement was generally higher than interagency agreement.

Following are some highlights of findings about the handicapped students studied, most of whom were mentally retarded or learning disabled:

1. Students in cooperative work-study programs were placed in a variety of jobs outside the traditional service occupations. (On the whole, students above IQ 84 and males were placed in more diverse and complex jobs).
2. As for their salaries, the students started their final jobs at an average hourly wage of \$2.32 per hour (range \$.50-7.25). At the time of the study, a large population of the students (69%) were earning \$2.30, the federal minimum wage, or more.
3. Employers were generally satisfied with workers from cooperative school programs perceiving them as frequently or almost always engaging in appropriate behavior at work.
4. VACs ratings indicated that students generally had good attitudes when they first took their final jobs and that they had adjusted well to the jobs.
5. Overall, the Texas students were performing at about the 40th percentile in terms of their total SPIB scores.
6. VACs and employers share similar perceptions of the performance of students, even though they observe students in different settings that make different demands on students. At the same time,

the VACS assessment of a student is higher when the student shows mastery of the kinds of information tested in the Social and Prevocational Information Battery. While knowledge is not all that is needed for successful adjustment, our findings suggest that the kinds of knowledge assessed by the SPIB bear at least a modest relationship to other kinds of outcomes, including employer and VAC evaluations of students. Wages were only modestly related to other measures of outcome, but it is quite likely that a student's salary depends on many factors in the placement process and the job market that have little to do with client abilities.

Attempts to account for why some students did better at graduation than others did were largely unsuccessful. Background characteristics, especially ability and parental support, tended to be better predictors of outcome than were services and programs received by the student. Analyses indicated several differences between lower IQ and higher IQ students in both experiences in the program and outcomes. Female students, comprising only 29% of the student sample, tended to be in less competitive, sex stereotyped jobs at graduation. Implications of the findings for improving school/rehabilitation partnerships are spelled out in a final report monograph.

APPLICABILITY: The idea for the proposed study originated with the Texas Rehabilitation Commission (TRC). Specifically, the program specialists in mental retardation voiced a desire for a study which would not only provide systematic information about the effectiveness of the cooperative school program, but also identify components of such programs which contribute to successful outcome. Because the Texas Rehabilitation Commission, the Texas Education Agency, and the R&T Center are full partners in conducting the study, its relevance and potentials for utilization are maximized. Because it appears that no studies focusing on relationships between process and outcome in cooperative school programs have been done elsewhere in the country, the present study will have potential relevance to program planning and design outside of Texas. Finally, this attempt at a process-outcome analysis should have heuristic value, stimulating further studies aimed at improving the benefits derived from cooperative school programs for handicapped youth.

255 Relationship Between Principal's Attitudes Toward the Retarded and Cooperative School Programs and Selected Program Factors

Principal Investigator:	Thomas Smith, Ed.D.	
Status:	Completed	
Dates:	June 1977-December 1978	
Cost:	Annual \$	Projected Total \$8,635
	RT Annual \$	RT % of Annual Total
Annual Report Reference:	#8, Page 79, R-39	

OBJECTIVES:

1. To determine the interrelationships among principals' attitudes toward the retarded, learning disabled, and normal person; principals' attitudes toward Cooperative School Programs, and vocational adjustment coordinators' (VACs) ratings of role performance of principals;
2. To determine the relationship between principal attitudinal variables and selected principal background variables;
3. To determine the relationship between principal attitudinal variables and VAC ratings of role performance of selected school staff and VAC ratings of program quality.

METHODOLOGY: This study is an exploratory survey of administrative variables which may be related to program variables of significance for successful operation of cooperative school programs (CSPs). A mail questionnaire was sent to 198 principals of schools with CSPs in the state of Texas, randomly selected from all the high schools in the state. Follow-up letters were mailed to respondents who did not answer at two and four weeks after the initial mailing.

There were three sets of questionnaires in the mailed packets:

1. Questions concerning background variables of interest, Background Information Form (BIF);
2. Questions concerning opinions about aspects of CSPs, Program Attitude Scale (PAS);

3. Semantic differential scales on the mentally retarded (MRATT), learning disabled (LDATT), and normal person (NPATT).

Data from R-30 were used to determine the relationship among the principal attitudinal data and variables related to program quality as perceived by VACs.

FINDINGS TO DATE: In order to study the relationships of interest, questionnaires on attitudes and background information were sent to the principals of the 98 schools participating in Project R-30 and an additional randomly selected 100 principals. A total of 129 respondents returned the questionnaires after two follow-up letters.

Ratings on 16 bipolar, 5-point adjective scales were obtained for the concepts of normal person, mentally retarded person, and learning disabled person. Tests of mean differences indicated that the semantic differential ratings of the mentally retarded person were less positive than those of the learning disabled ($t=3.79, 97 \text{ df}, p < .001$), and the normal person ($t=9.74 \text{ df}, p < .001$) and ratings of the learning disabled person were significantly less positive than those of the normal person ($t=8.02, 97 \text{ df}, p < .001$). Examination of the means showed that although the learning disabled person was perceived more favorably than the mentally retarded person, the mean for learning disabled is closer to the mentally retarded mean than to the normal mean.

Another indicator of administrative attitude which was collected for this study was a 16-item scale on attitudes toward aspects of CSPs. Item means indicated acceptance of the concept and basic operational procedures of cooperative school programs, but some controversy regarding diplomas, payment for on-campus work, serving severely handicapped youth, and the role of the vocational rehabilitation counselor.

VAC ratings of principal performance and principal attitude toward the learning disabled were significantly related. Probably the most significant were the correlations found between the principals' program attitudes and attitude toward the handicapped groups predominantly served by CSPs. These findings suggest administration support, a key to effective operation of CSPs, may require extensive in-service training focused on principals' relationships to CSP programs as well as their basic attitudes toward these students.

Background information on administrative and CSP experience and types of contact with the mentally retarded showed that amount of experience with the cooperative school program, both as a teacher and as a principal, was related to mean program attitude (for years as teacher $r=.36, p < .001$; for years as a principal $r=.32, p < .001$). Attitudes toward the retarded and teaching experience with the mentally retarded were also positively related.

The mean semantic differential ratings of the mentally retarded and the learning disabled person were correlated with the VRC ratings of each of 13 school staff roles and 15 factors of importance to CSP operation. The role ratings of the regular school counselor, the TRC counselor and TRC supervisor were negatively correlated with the principals' attitude toward the retarded, suggesting that the persons in those roles may have performed beyond the call of duty in the face of principals who were not accepting of the mentally retarded students in the program.

Of the program factors rated by VACs, relationships between CSP and other school staff, cooperation from students' parents, availability of appropriate jobs, and supervision of students by employers were all significantly related to principals' attitudes, with only the first being a positive relationship. It appears again that with these factors, as with the staff role performances, a prejudiced principal in the school may induce extra efforts and cooperation by others in the service of the CSP. The project identified several areas in which efforts to strengthen administrative support might be useful.

APPLICABILITY: The total school environment is essential for the rehabilitation of retarded youth. The degree to which the members and departments of the school community work in unison to benefit the retarded can have much impact on CSPs and their success in rehabilitating retarded youth. The principal as the leader in the school has great influence on whether other school staff cooperate with the efforts of the CSP staff. Understanding how the principal affects cooperative work-study programs is likely to suggest ways of strengthening these programs.

256 Models for Services to the Severely Handicapped

Principal Investigator: John Felt Buddington, Ph.D.
Status: Completed
Dates: September 1977-August 1978
Cost: Annual \$ Projected Total \$106,734
RT Annual \$ RT % of Annual Total
Annual Report Reference: #8, Page 92, R-43

OBJECTIVES: The objectives of this project were to provide description of the actual operation of two rehabilitation agencies which had evolved innovative approaches to providing rehabilitation services to the severely handicapped. These descriptions were to be written in such a way as to be "replicable" by five rehabilitation facilities in the second and third years of the project. An analysis of the elements of the operations would be used to develop a generic model of rehabilitation agency service delivery to severely handicapped clients.

METHODOLOGY: The project will produce the descriptions of the operation programming and the generic program in the course of four phases. These phases include:

Phase I: Preparation and Planning

This phase will yield at least two models which describe (a) the objectives of the project, (b) a set of intermediate states of the project which denote its progress in meeting its objectives, (c) monitors which document its success, (d) procedures for attaining each intermediate state, (e) procedures to improve the project's effectiveness over time, and (f) all other activities necessary to support the above.

Phase I will be completed by abstracting the literature, making site visits, describing two models, and revising these models with the advice of selected members of CSAVR.

Phase II: Request for Proposals

This phase is designed to yield at least five proposals which promise to serve severely handicapped individuals in a more effective fashion than is being done by existing services.

Phase II will be completed by distributing the models derived from Phase I to state vocational rehabilitation and blind agencies. Details of how the states may respond to the RFP will be included. Consultation to assist states in preparing their proposals will be offered.

Phase III: Technical Assistance

This phase is designed to yield five programs which operate in the fashion promised by their respective proposals. Phase III will be initiated by the granting of roughly \$100,000 from RSA to each of five vocational rehabilitation agencies. Site visits will be made by project staff to assure that the technical aspects of the proposal are being carried out as promised. Project staff will be available during site visits and at other times for consultation.

Phase IV: Evaluation

This phase will yield a description of the results actually attained by each of the five projects, two years after funding, as measured according to the objectives adopted by each agency. In addition, changes in the operation of the agency will be described, together with any deviations from the proposal. The description of the actual status of the five funded agencies (including any planned changes and any deviations from the proposal) will constitute the "description of operating agencies" called for in the first objective of this project. A generic description of a rehabilitation agency, the second objective called for, will be derived from the description of the five agencies in combination with the "sample description" completed in Phase II.

FINDINGS TO DATE: This project was completed in October, 1978, with the submission of a final report entitled, **A Model for Services for Severely Handicapped Individuals.**

The initial plan in this project was to design, in cooperation with CSAVR and RSA, several models representing extensions of the state-of-the-art in delivering rehabilitation services to the severely handicapped. The models (originally five, later modified to one), were intended to go beyond what was currently being done to serve the severely handicapped, but were still to be feasible within legislative authorization of the 1973 Rehabilitation Act as amended. The project plan

called for a meeting with selected representatives of RSA, CSAVR, advocates for the handicapped, and consumers of rehabilitation services to identify populations and service needs to target, on the assumption that any workable model(s) would have to be restricted in scope. The development of the model occupied the first year of activity after the project was funded. The second and third years of the project were to be utilized in funding five state agencies to implement the model and evaluating its effect upon delivery of rehabilitation services to severely handicapped individuals. Due to a lack of funding to implement the model in the state agencies, personnel changes, anticipated legislative policy changes, and difficulties in coordination between RSA, CSAVR, and the R&T Center, the project concluded after the first year with the submission of a model for delivery of selected services to primarily homebound severely handicapped persons.

The model describes a 6-week program in which severely handicapped individuals, many of them homebound, receive training intended to foster independence. A syllabus outlines the content and methods for units in the following areas: personal goals, project goals, leisure time managements, mobility, living arrangements, functional skills, consumer affairs, finances, self concept, family life, raising children, friends and relationships, work and finding employment.

In addition, the model describes project management, the management information system, evaluation procedures, supporting activities, and activities for the improvement of the program. The model is written in the style of a grant request for federal support.

APPLICABILITY: As originally planned, an agency service model which meets the requirements of the 1973 Rehabilitation Act could be adopted by an agency which adopts the same statement of responsibility as the model. The model description produced was in conformity with most program-planning and budgeting procedures, including MBO and zero-based budgeting. Agencies adopting these descriptions would have to specify little more than the details of what individuals will staff the agency and where the offices will be located. They would, however, have to develop their own implementation plan to put the description into operation in their particular locality.

257 Factors Underlying Successful Adjustment of the Retarded Released from Institutions

Principal Investigator:	Nancy J. Bell, Ph.D.	
Status:	Continuing	
Dates:	July 1973-July 1979	
Cost:	Annual \$11,665 RT Annual \$8,395	Projected Total \$195,000 RT % of Annual Total 72%
Annual Report Reference:	#8, Page 195, R-21	

OBJECTIVES:

1. To assess changes in the characteristics of the retarded individuals who are furloughed and discharged from residential facilities during an eight-year period.
2. To study the relationship between individual characteristics of the retarded persons and the critical behaviors they exhibit which result in success or failure in community adjustment.
3. To evaluate the role of various supportive services which are important in maintaining retarded persons in the community.
4. To study the quality of the personal, social and vocational life of retarded persons who have been furloughed or discharged from state residential facilities.
5. To compare the procedures and operational philosophies regarding furlough and discharge of residents in eleven residential facilities.
6. To assist not only the Texas Department of Mental Health and Mental Retardation, but agencies throughout the country, in developing more effective plans for selecting and training retarded individuals for community placement and for developing community services.

METHODOLOGY: The first stage of this project involved mailing questionnaires to a sample of 500 former residents of Texas state schools for the retarded who were discharged from 1968-1973. Various topics relating to community adjustment were addressed in these questionnaires. Background data on each subject were provided by the institutions. Personal interviews were conducted with a sub-sample of both those who responded and those who did not return the mail questionnaire. Stage One of the study was designed to permit comparison of those discharged in past years with those furloughed from institutions in 1974 in Stage Two. Stage Two of the study involved a longitudinal follow-up of those individuals furloughed for at least 90 days from any of the Texas state schools during 1974. These people were contacted shortly after separation from the institution and then periodically thereafter for approximately 2-½ years. Individuals from all age and ability levels were included in the sample. At each community contact, information was obtained from a personal interview with the client, a guardian or houseparent interview, and observations made by the interviewer about the client's behavior and environment. Guardians or houseparents were also asked to complete an adaptive behavior rating form. This rating, along with ratings of work skills, were also provided by state school personnel at the time of a subject's furlough. Upon a client's return to the institution, guardians and state personnel were asked to provide information about reasons for return and problems encountered in the community. Information was obtained for all subjects in the form of background and psychometric data from institution records. In order to compare community lifestyles and problems of previously institutionalized retarded persons with those of nonretarded community residents, a short form of the client interview was administered to 151 residents of Lubbock, Texas, who were similar to the retarded sample in age, sex, and ethnic characteristics.

FINDINGS TO DATE: Mail Survey. Based upon information obtained from approximately 39% of the sample, there were lifestyle differences between ability groups (IQ below 55 and IQ 55 or above) on most variables examined. The lower ability group was living a more sheltered life and appeared to be more dependent upon others than the high ability group. Examining adaptive behavior scores in relation to employment suggested that some minimal level of skills may be important, but beyond this minimum level, increasingly higher scores did not differentiate the unemployed from those employed. Thus, while it might be possible to develop predictive estimates of the likelihood of employment and degree of independent living based upon IQ and adaptive behavior scores, this prediction would not be very precise. The most important difference between high and low ability individuals may involve a variety of community support factors. These environmental factors include kind of training received while in the institution and agency assistance in the community. Those with IQ's above 55 received more training and agency support than did the lower ability group, which may in itself be a primary reason for community lifestyle differences. In comparing leisure activities of retarded persons with the non-retarded, the respondents were divided into three major groups for analysis: moderately retarded (IQ below 55), mildly retarded (IQ 55 and above), and community sample. Types of leisure activities were categorized as community interaction (attendance at movies, restaurants, clubs, etc.) or social activities (contact with friends, dating, etc.). In community interaction activities, the mildly retarded did not differ from the community sample. In the areas of social activities, however, participation of the community sample exceeded that of the mildly retarded group, which in turn exceeded that of the moderately retarded. Differences between the groups in socio-economic and marital status are possible explanations, as are IQ-related differences in social knowledge and skills, differences in opportunities to meet people and possible constraints placed on social life by living at home with parents. Personal evaluation of lifestyle was measured by responses to items asking which things were problems from the respondent's point of view. A greater number of the retarded than of the community group reported problems finding friends (same and opposite sex) and problems figuring out what to do with their time. **Longitudinal Follow-Up.** Data collection was completed in June, 1976. A total of 582 individuals were included in the sample. The final current status on each client was established as of October 31, 1976, three years after the first furlough reports were received. As of that date, 55% had received discharges from the institutions, 32% were still on furlough status, 12% had returned and were residents of the institutions, and 1% were deceased. Analysis of differences between those who remained in the community versus those who returned to the institution at any point has revealed that the returnees were likely to be older (over 30); placed in group homes or with employers; and placed near state schools. Returnees also tended to have less income and less involvement in social relationships and activities. Interestingly, lower IQ clients were no more likely to return than higher IQ clients. Major analyses of the longitudinal data currently underway are designed to clarify: (1) what the status

and experiences of clients are at different time periods after furlough; (2) what variables change significantly over time; and (3) what variables predict adjustment at various times. Findings to date indicate that most indicators of community adjustment are remarkably stable over time.

APPLICABILITY: This study will provide general feedback on the current status of clients who have been institution residents and permit comparisons of those discharged in the past with those currently being placed in community settings. The identification of particular areas of difficulty shortly after separation from the institution can provide the basis for expanding or altering emphasis in existing pre-release training programs. Similarly, difficulties occurring later after separation may suggest the need for certain types of community support programs. These are potential long-range implications of this information for selecting and placing residents. This study, perhaps in combination with the results of other recent studies of the same type, may permit fairly good prediction of which individuals will do well in community placement at a given point in time and thus are ready for separation, as opposed to those who would benefit from additional training. Also, it may aid in identifying important determinants of the type of placement most suitable for a given individual. It is hoped that the findings will aid both institutions and community agencies in deinstitutionalization efforts and in providing appropriate supportive services.

258 Study of Consumer Needs, Circumstances, and Attitudes

Principal Investigator:	Carol K. Sigelman, Ph.D.	
Status:	Continuing	
Dates:	January 1977-August 1979	
Cost:	Annual \$74,425 RT Annual \$58,075	Projected Total \$120,000 RT % of Annual Total 79%
Annual Report Reference:	#8, Page 217, R-34	

OBJECTIVES: The President's Committee on Mental Retardation commissioned this study with the main objective of determining whether a national consumer sampling approach is a feasible way of quickly determining the needs and attitudes of the retarded in such a way that national policy could be formulated based on the information received. The feasibility of such an approach will be determined by: (a) developing procedures which address problems of identifying and accessing a representative sample of retarded persons; (b) determining the most valid and reliable interviewing techniques to be used with a retarded population; (c) developing written guides and training procedures for interviewers; and (d) testing the adequacy of interviewing techniques used as a data base for policy-making. This study will also seek to meet PCMR's second objective of providing information on the needs, circumstances and attitudes of a sample of retarded persons with respect to: (a) the extent to which community services are available, known to, utilized, and positively received by the retarded consumer; (b) the nature and quality of his/her living circumstances; and (c) the extent to which he/she has the opportunity for decision making in regard to his/her life circumstances.

METHODOLOGY: Review of previous prevalence estimation studies will be the primary methodology for identifying issues in sampling. In order to determine the feasibility of actually locating, gaining clearance for, and obtaining consent from subjects, major agencies will be polled by mail on their policies regarding release of information about clients. Also, during the interviewing of the retarded subjects, extensive records will be compiled on problems encountered and time spent with various techniques of accessing subjects. Content areas have been limited to: (a) availability, accessibility, need for, use of, knowledge of, and attitudes toward services for the retarded; (b) nature and quality of residence, income, and social life; and (c) opportunity for and experience in decision making. Instruments to be developed include a background information form, and agency survey, a client interview form, a parent or "significant other" form, and an interviewer observation form. A series of pilot studies will be completed to explore determinants of responsiveness, reliability and validity, as well as to guide the selection of questions for the final interview schedule. This series of pilot studies will result in a final questionnaire which optimizes responsiveness and reliability and validity of response as well as research reports which clarify several critical issues in the feasibility of interviewing mentally retarded persons.

FINDINGS TO DATE: A series of activities, involving input from PCMR and preliminary interviewing, culminated in the development of questionnaires to be used in assessing the feasibility of interviewing mentally retarded persons across the IQ range. Literature reviews are nearly completed of communication skills of the mentally retarded, response sets in interview research and prevalence estimation, and research regulations have been studied through national mailings requesting information on a variety of agencies and organizations. Two interview studies, one of institutionalized children and one of institutionalized adults, was conducted. In each case, 50-60 residents of different levels of mental retardation were interviewed with alternate forms of an interview schedule administered a week apart, and attendants at the institution provided answers to most of the same questions that clients answered. Analyses indicate a strong relationship between IQ and ability to respond appropriately to questions; several difficulties at all levels of retardation involving inconsistencies among responses to alternate phrasings of questions on the same topic e.g., the operation of an acquiescent response set; and relationships of both responsiveness and consistency of response to the type of question format used (e.g., yes-no, either-or, open-ended). Response biases on the part of clients have tended to reduce agreement between clients and their parents or attendants, especially on yes-no questions. Either-or questions, sometimes accompanied by pictures, have emerged as the most promising way of optimizing responsiveness and validity of response. Findings of the study raise major questions about and provide some solutions to the problems in using survey research methodology with retarded populations to examine reliability of response.

Children living in the community and a small sample of adults living in the community have also been interviewed, and severely retarded subjects at the institution involved in the reliability studies have also been reinterviewed in an attempt to further explore promising techniques of interviewing low verbal persons.

APPLICABILITY: The study will provide an assessment of the needs of the severely retarded and the multiply handicapped, as well as information about how well agencies are meeting their needs and those of the entire range of mentally retarded persons. This is especially relevant due to the current emphasis on serving the severely handicapped and providing programs for them at the community level. In order to fulfill the spirit of consumerism in current legislation for the handicapped and to provide a mechanism for feedback, some assessment of the attitudes of the handicapped toward rehabilitation agencies needs to be made. This project will be designed so as to obtain information which should be readily used by service agencies in better understanding their clients and enabling them to better meet the clients' needs.

259 Effects of Job Enrichment on Work Performance of the Mentally Retarded

Principal Investigator:	Andrew S. Martin, Ph.D.	
Status:	Continuing	
Dates:	June 1977-December 1979	
Cost:	Annual \$17,450 RT Annual \$14,375	Projected Total \$43,625 RT % of Annual Total 62%
Annual Report Reference:	#8, Page 12, R-36	

OBJECTIVES: The overall objective of this project is to study the process of job enrichment and the effects of enriched jobs on the work behavior of retarded persons.

The specific questions under investigation are:

1. Does an enriched job provide more **intrinsic** motivation than a simplified job for retarded workers? More precisely, do retarded persons perform better (i.e., have higher output and fewer errors) in a job which contains more varied elements (horizontal loading) and more discretionary or decision elements (vertical loading) than they do in simplified low cycle time jobs?
2. Are any benefits which accrue from enriched jobs due to the enriched jobs themselves, or to the **process** of job enrichment?

METHODOLOGY: The participants in this pilot study were fourteen clients at the sheltered workshop of the local MHMR center. There were six females and eight males with an IQ range of 17 to 68 (m=42).

The simplified and enriched jobs were, respectively, the partial and total assembly of eight piece ball point pens. These jobs were novel to all clients at the beginning of the study. The clients worked for thirty minutes a day in a small room which was separate from the main workshop area.

The study used two levels of jobs (simplified vs. enriched) and two sequences of program implementation in an A-B: B-A design. Half of the participants started on the enriched job and changed to the simplified job after approximately 24 days, while the other half of the participants performed the two jobs in reverse order.

The clients were paid two cents for each total pen assembled and a proportionate fraction for each partial assembly. They were paid at the end of the study for all of the work they had done during the study.

FINDINGS TO DATE: Preliminary inspection of the data indicated that some of the participants responded to the treatments as hypothesized (better performance under the enriched condition) while others seemed to behave just the opposite. Self-reports by some of the higher level participants during the course of the study indicated that they preferred the enriched condition. Thus, for further analysis, the clients were divided into high and low IQ groups. The low group had an IQ range of 17-41 ($m=29.8$) while the high group ranged from 44-68 ($m=52.7$).

The data were transformed to percent of "normal" output based on a sample of R&T staff members so that comparisons could be made between the two jobs. Analysis of the data from the two IQ groups led to some rather unexpected findings. The high IQ participants who started on the simplified job showed a substantial increase when they were switched to the enriched job. Those high IQ participants who started on the enriched job decreased slightly when changed to the simplified job. These results are consistent with those typically found with non-retarded workers in job enrichment studies. However, the low IQ participants performed in an opposite and quite unpredicted manner. Those who began on the simplified job decreased when changed to the enriched job while those who started on the enriched job increased when changed to the simplified job.

Dividing the groups by IQ produced sample sizes so small as to preclude parametric analyses. For this reason, median tests were performed on the data from the low and high IQ groups. These tests indicated that the high IQ group performed significantly better on the simplified job.

As mentioned earlier, several of the high IQ participants expressed their preference for the enriched job and often complained that the simplified job was boring. No such complaints were voiced by the low IQ participants. Anecdotally, however, several of the low IQ participants seemed to be interested in the sheer number of assemblies they completed each day. Of course, they were able to produce many more of the assemblies in the simplified condition. Perhaps this is what motivated them to work faster on the simplified job.

Admittedly, these findings are based on very small sample sizes and, thus, probably should be taken as a pilot study until replicated with larger numbers of participants. Further studies are planned with larger samples and other jobs.

APPLICABILITY: Past efforts at rehabilitation of mentally retarded persons through work-vocational rehabilitation have been haphazard efforts to establish a work situation, or a "work like" atmosphere, in which it is hoped that something would happen to the retarded client to make him/her a better person. These efforts are not haphazard by design, but are, in most instances, extremely well intentioned efforts to help, in the absence of knowledge of how to help. This line of research seeks to provide information about the ways in which job organization affects the work behavior of mentally retarded workers. This particular study indicates that mentally retarded workers are sensitive to the enrichment and simplification of tasks. However, the study also demonstrated that high and low IQ workers are not affected in the same way and thus, further serves to caution us that mentally retarded people do not constitute a single, homogeneous population.

260 Effects of Goal Setting Training on the Job Performance of the Mentally Retarded

Principal Investigators: Robert W. Flexer, Ph.D.
Brenda J. Raney, B.S.
Status: Continuing
Dates: June 1977-June 1980
Cost: Annual \$55,053 Projected Total \$165,159
RT Annual \$42,913 RT % of Annual Total 78%
Annual Report Reference: #8, Page 23, R-38

OBJECTIVES: Two major objectives will be addressed to maintain productive behavior and to delay tangible or primary reinforcement over one week periods. Through fractionation of the long-range goals (dividing long-range goals into shorter intermediate goals) and reinforcement of the goal setting behaviors with feedback systems and further incentives such as bonuses, attempts will be made to shape sustained performance over one week periods. Finally, through a fading of reinforcement and fractionation of goals this study will investigate the possibility of maintaining productive behavior of clients in sheltered workshops while remaining on the usual one-week pay schedule.

METHODOLOGY: The basic question addressed in this programmatic research effort is: Do the setting and attainment of monetary goals spanning one week serve as an effective motivation for the mentally retarded? Two comparisons will be made to answer the question. Individual performance work will be on a piece-rate system (e.g., one penny for each assembled ball point pen). In addition to within subject controls, group performance under treatment will be compared to a control condition where feedback on earnings will be administered on a daily basis.

For the within subject assessment, clients will be placed under baseline conditions, work under conditions or goal setting, return to baseline, then return to goal setting. The same number of clients will undergo an ABAB design but only receive feedback on earnings. A between subject assessment will be made for the goal setting treatment clients and the control feedback clients for the B portions of the program. Ten clients will be administered each of the treatments.

The procedures to be used are:

Baseline: Clients will be told that they will receive payment for the number of pens they assemble every Thursday, pay day for sheltered workshop clients. Baseline conditions will continue until clients have shown stable performance. The same conditions will be readministered following the first treatment and control administrations.

Treatment: Clients will be assigned monetary goals to attain. The production rate under baseline conditions will be pro-rated over five days to obtain a total goal amount. Clients will work until they reach the goal. As soon as clients reach the goal amount, they will be assigned a new goal. Feedback will be administered daily to show progress toward the goal. Three goals will be assigned during the first treatment segment. A second treatment segment will be administered following reinstatement of baseline conditions.

Control: Control clients will be shown daily how much money they made and the money will be deposited in a bank to be paid at the end of the work week.

Subsequent studies will employ the same design, but under the second treatment phase in the ABAB design variations of technique for assigning goals and giving feedback about progress toward goals will be tested.

FINDINGS TO DATE: Several studies were completed under this project in the past year.

In the first "Long- and Short-Range Goals in Work Adjustment Training of Mentally Retarded Persons," improvements in production rate were evident for clients in both the long-range and short-range goal programs. These findings support the efficacy of goal setting in training work adjustment skills for the mentally retarded. The treatment for the short-range goal groups proved to be more effective than the treatment for the long-range goal group. The investigators antici-

pated that the short-range goal treatment would be more effective since retarded persons are supposedly most responsive to behavior change programs which provide immediate feedback and frequent reinforcement however, in the long-range goal treatment, where feedback on goal attainment and contingent social praise came only once every two weeks, clients increased their production an average of almost ten pens from Phase 1 to Phase 2 compared to a three pen increase for the short-range goal group. These findings intimate that mentally retarded persons are capable of learning to manage their own work behavior in pursuit of distant goals.

In another study "Effects of Goal Setting Training on the Job Performance of the Mentally Retarded," clients were divided into two groups: (a) Goal Setting and, (b) Control-Daily Feedback. In the goal-setting group the baseline production rate was pro-rated over five days to obtain a goal. Daily feedback was provided to each client concerning goal attainment. As soon as a goal was attained, the client was paid. In the control group the clients were given daily feedback concerning the amount of money earned for the day. They were paid once weekly.

The results of the treatment administered indicated a substantial, but not significant gain in mean production for the goal-setting group suggesting that information and feedback relative to movement toward a goal can elevate production rates in the mentally retarded. Monetary reinforcement and daily feedback were the two important variables in increasing production for both groups, but the goal-setting feedback heightened production in the goal-setting group.

APPLICABILITY: Previous studies by the authors have focused on whether severely retarded persons can delay gratification and work toward long-range goals. Types of goals have been varied, as has the length of time required to reach the goal. These studies have shown that the severely retarded can in fact work for longer range gratification. The present series of studies is designed to investigate different types of feedback systems for relaying information to clients about their progress toward a goal and to test the limits of these systems. These studies complement other work being done at the Texas Tech R&T Center, and other MR centers, in that they focus on maintenance of performance in a training and work setting. The importance of these studies for the rehabilitation of retarded persons rests on the generalizability of these systems to any work setting for the retarded, and their compatibility with different training systems. The studies in this proposal of prime importance since, as earlier studies have pointed out, severely retarded persons can be trained to produce quality products at competitive rates, but when they moved from a training setting into a sheltered workshop with no maintenance program their performance deteriorated. Feedback systems of the type to be investigated in the present studies can be easily installed in work settings, or incorporated into job design, to help provide the necessary maintenance support to keep skills and behaviors acquired in training at a high level.

261 Vocational Handicapping Conditions as a Function of IQ

Principal Investigator:	Carol K. Sigelman, Ph.D.	
Status:	Continuing	
Dates:	June 1977-May 1980	
Cost:	Annual \$76,625 RT Annual \$40,147	Projected Total \$120,000 RT % of Annual Total 52%
Annual Report Reference:	#8, Page 100, R-40	

OBJECTIVES:

1. To identify and compare the needs and deficits of persons in the severe, moderate, mild, and borderline levels of intelligence in such areas as personality, adaptive behavior, sensory and motor functioning, vocational aptitudes, and work-related behaviors.
2. To describe the rehabilitation process for such persons in both rehabilitation and school settings and to examine how the process differs for clients of different intellectual levels.
3. To measure outcomes of rehabilitation services and determine relationships between outcome and (a) intellectual level, (b) functional levels, and (c) types of services received.

METHODOLOGY: In response to input from state rehabilitation agencies in the region, the study will focus

on school populations as well as on clients referred to rehabilitation agencies from other sources in Arkansas, data collection will center on a vocational evaluation unit which serves the entire state; in Texas, the study will focus on school populations, and will have a secondary objective of evaluating the benefits of programs which stress vocational training for the handicapped as compared to more traditional work-study programs. In all settings, subjects identified for study will first be evaluated with a comprehensive battery measuring functional capacities considered to be predictive of later adjustment. Most of the measures will involve individual testing, although ratings of adaptive behavior will also be collected. Questionnaires will be used to collect information about the programs and services which these clients then receive. Adjustment to a work setting will be assessed with a rating scale completed by work supervisors, and finally, through interview procedures and client evaluation, benefits derived from rehabilitation services will be assessed approximately two years after the initial assessments are conducted.

FINDINGS TO DATE: Literature reviews on the relationship of IQ to social and vocational adjustment of the mentally retarded and on the special problems of learning disabled persons were completed, and a battery of assessments was identified. Data collection began in the summer of 1978 at a rehabilitation unit in Arkansas, where comprehensive assessments of approximately 45 persons were completed. Analysis of these evaluations focused on differences between clients in different IQ ranges. Surprisingly, few differences were found between clients in the moderate range of retardation (IQ 40-54), the mild range of retardation (IQ 55-69), and the range previously labeled "borderline retarded" (IQ 70-84). These findings suggested that many persons in the borderline IQ range have functional deficits much like those of lower IQ retarded clients and that adoption of the new American Association of Mental Deficiency definition of mental retardation would mean denial of rehabilitation services to individuals with significant vocational handicaps. Negotiations with the rehabilitation agencies in the region will guide future studies.

APPLICABILITY: Rehabilitation agencies have expressed concern regarding the implications of introducing the American Association on Mental Deficiency's definition of mental retardation into rehabilitation practice because they perceive that many persons in the borderline range of intelligence, who would no longer be considered mentally retarded, have difficulties which constitute a vocational handicap and can benefit from rehabilitation services. Thus, this study should identify the nature and extent of deficits in this group as compared to mentally retarded groups, as well as indicate problems the borderline IQ person encounters during rehabilitation and eventual outcomes. At the same time, by attending to the severely mentally retarded client, the study will provide guidance to rehabilitation agencies as they strive to fulfill the mandate to give priority to the severely handicapped by indicating the functional deficits in this group and the clinical relationships between process and outcome in their rehabilitation.

262 Interview Skills of the Retarded: Deficiencies, Consequences and Training Approaches

Principal Investigator:	Carol K. Sigelman, Ph.D.	
Status:	Continuing	
Dates:	September 1977-September 1979	
Cost:	Annual \$31,950 RT Annual \$24,725	Projected Total \$63,900 RT % of Annual Total 77%
Annual Report Reference:	#8, Page 239, R-41	

OBJECTIVES: The main objective of the study is to establish, by presenting videotaped interviews to personnel interviewers, rehabilitation counselors, and college students for ratings, which verbal and nonverbal skills are predictive of the mentally retarded client's making a favorable impression in a job interview situation, and which, as a consequence, would be prime targets for training efforts. Additional objectives are as follows:

1. To establish for a population of severely to mildly retarded adults the level and variability across subjects of verbal and nonverbal communication behaviors;
2. to determine relationships among communication behaviors;

3. to assess the relationships between communication behaviors and client characteristics such as sex, IQ, adaptive behaviors, and length of institutionalization;
4. to determine whether communication skills are predictive of current vocational functioning levels;
5. to determine the extent to which responsiveness to the demands of a question is a function of the type of question asked;
6. to assess the extent to which providing raters with information about client intelligence, motivation, and job skill reduces reliance on communication behaviors as a basis for evaluative judgment; and
7. to test the relative effectiveness of modeling and videotape feedback procedures in modifying communication skills found to be deficient and associated with making negative impressions on raters.

METHODOLOGY: Eighty-eight mentally retarded adults (both males and females) in the severe, moderate, and mild ranges of retardation were videotaped while participating in a "pretend" job interview situation. All of the subjects came from an institutional setting.

A standard interview format was constructed covering two topic areas: vocational maturity and social maturity, with sixteen parallel questions in each topic area. Within topic areas, the types of questions asked (e.g., yes-no, either-or, what questions, and open-ended questions) were systematically varied so that responsiveness to communication demands could be examined as a function of question type. The interviews lasted approximately 5-10 minutes, and were preceded by a warm-up period during which the research and the presence of the videotape camera were explained.

Measures of communication performance in the interviews consist of the following: (1) responsiveness to communication demands of questions; (2) number of words in garbles, phrases and one word responses, and T-units; (3) total number of words; (4) number of T-units; (5) frequency of eye contact; (6) smiling; (7) head obstruction; (8) fidgeting; (9) speech intelligibility; and (10) physical attractiveness. Many of the verbal and nonverbal measures were used in the pilot research, but several new measures have been added to enhance predictive power.

Data on client characteristics such as sex, IQ, length of institutionalization, and adaptive behavior have been collected from client files. Correlational analysis and analysis of variance were used to examine the relationships of these variables to communication behaviors, as well as the relationships among communication measures.

Segments of the videotapes for the 88 subjects were arranged in random order and prepared for presentation to rating groups. All interviewees were shown responding to the same 8 questions from the job interview format with each segment lasting approximately one minute. Three rating groups viewed the tapes: (a) personnel interviewers, obtained through business administration classes at Texas Tech; (b) vocational rehabilitation grad students; and (c) graduate students in Special Education. An interview rating scale which consists of semantic differential style items with seven points along a positive-negative continuum concerning intelligence, communication, personality, employability, was used. Each rating group viewed all 88 taped interviews so that differences among rating panels would not confound the analysis. Each of the three rating panels consisted of four to six persons and reviewed tapes in four installments of 22-23, so that fatigue would not enter in.

The previous analysis provided the basis for selection of skills to be trained. Skills which proved to be deficient in a substantial proportion of the population and which were significantly correlated with evaluative ratings became the target behaviors to be modified. These skills included eye contact, smiling, speech intelligibility, and responsiveness to the communication demands of questions. Subjects were randomly assigned to one of three groups: (1) videotaped feedback, (2) nonvideotaped feedback, and (3) interview practice control.

The subjects' performance in the standard interview will serve as pretest measures of baseline performance. Following treatment, the subjects were again videotaped responding to the same interview questions administered by the same interviewer. Posttreatment communication scores will be obtained on the target behaviors. The posttreatment videotapes will also be viewed by one of the same group raters previously used, new ratings will be obtained, and changes calculated.

FINDINGS TO DATE: The following findings have emerged from the study in which 88 retarded adults at the Lubbock State School participated in simulated job interviews:

1. Responsiveness to communication demands of different types of questions was in part a function of the type of question asked.
2. Verbal and nonverbal behaviors were generally independent of one another. With the exception of smiling, highly verbal subjects were no more likely than those with limited verbal skills to engage in positive nonverbal behavior.
3. While one could predict verbal skill from IQ score, nonverbal performance could not be so predicted.
4. While verbal measures overshadowed the nonverbal measures as predictors of ratings, both nonverbal and verbal performance measures predicted impressions made in the interview.

IQ, the four verbal measures and the five nonverbal measures were used to predict ratings of intelligence, personality, quality of communication, general impressions made in the interview, and the likelihood that the rater would hire the applicant. These ten measures accounted for nearly 70% of the variance in the total ratings given by business administration students, graduate students in special education, and graduate students in rehabilitation counseling, and 50 to 70% of the variance in hiring decisions. Subjects who gave adequate responses to questions, made frequent contact with the interviewer, smiled appropriately, and whose speech was understandable tended to be rated positively. While verbal behaviors were the most powerful predictors of ratings and hiring decisions, nonverbal behaviors were the subject of 57% of the raters' comments in response to a question asking them which things the applicant said or did which made a marked impression on them.

It was felt that these findings were promising enough that they should be pursued. The findings of the study suggest that training in conversation skills is especially important. Moreover, there is some justification for training certain nonverbal behaviors such as smiling and appropriate grooming. The next step will be to analyze the data from the training phase of the program to determine whether training in these skills does indeed enhance impressions made by mentally retarded persons in interviews.

APPLICABILITY: The study is directly relevant to rehabilitation practitioners concerned with communicating with mentally retarded clients and increasing their clients' competencies in job interviews and other social interactions. Specifically, it identifies communication skills which are deficient; sheds light on the effects of the types of questions posed to the mentally retarded on their communication behavior; offers information about how rehabilitation professionals and others react to the communication behaviors of the mentally retarded; indicates which communication behaviors are consequential enough to warrant intensive training efforts; and evaluates alternative methods of training important communication skills.

263 Issues in Deinstitutionalization

Principal Investigator:	Carol K. Sigelman, Ph.D.
Status:	Continuing
Dates:	September 1977-February 1980
Cost:	Annual \$21,340 RT Annual \$16,445
	Projected Total \$32,010 RT % of Annual Total 77%
Annual Report Reference:	#8, Page 262, R-42

OBJECTIVES:

1. To describe the adjustment processes of more severely disabled persons furloughed from state institutions for the mentally retarded in Texas to the community, comparing them to higher level clients.
2. To assess which types of clients receive which types of environmental support, which types of environmental support facilitate adjustment, and which types of clients benefit from such supports.

3. To determine, for a sample of persons for whom both clients and guardian or houseparent interviews were collected, the extent to which clients and significant others agree in their responses, and the extent to which profiles of adjustment and correlates of adjustment from these two sources of data are consistent.

METHODOLOGY: This study is an extension of analyses of a large longitudinal data set collected as part of Project R-21. The methodology consists of data set organization, data reduction, and statistical analysis appropriate to the stated objectives.

FINDINGS TO DATE: Due to shortages of funds, the present project, although approved for initiation, has been held in reserve for a late start until appropriate staff are available.

APPLICABILITY: Deinstitutionalization has been a priority in both RSA and the Office of Development Disabilities. The Center's rich longitudinal data set is unique and can provide knowledge relevant to community adjustment processes and the facilities and services which facilitate those processes. In this study, special attention will be focused on the more severely handicapped person and on environmental, as opposed to personal, correlates of adjustment.

264 Development of Exemplary Models of Achieving Effective Coordination of Education and Vocational Rehabilitation in Local Communities

Principal Investigator:	Gerard J. Bensberg, Ph.D.	
Status:	Continuing	
Dates:	October 1977-September 1979	
Cost:	Annual \$133,712 RT Annual \$120,750	Projected Total \$133,712 RT % of Annual Total 90%
Annual Report Reference:	#8, Page 118, R-44	

OBJECTIVES: The purpose of the project is to determine what forms and mechanisms of cooperative programming by vocational rehabilitation, public school programs, and other community agencies can improve the quality of services to handicapped youth. Specifically, the project will culminate in a state of the art report, detailed descriptions and analyses of ten exemplary programs involving interagency cooperation, and a synthesis of models in a model or models replicable nationally.

METHODOLOGY: Literature review will focus on describing current public school/vocational rehabilitation programs and interagency linkages and will serve as background for describing the state of the art and constructing questionnaires and interview schedules to be used in site visits. A form will be developed to solicit nominations of outstanding programs from vocational rehabilitation agencies, state education agencies, and other relevant sources. A follow-up questionnaire will be sent to nominated programs to solicit information that can be used, along with telephone contacts, as a basis for selection of ten exemplary programs. Site visits will be conducted by a carefully chosen visitation team using structured and open-format questionnaires, interview schedules, and data collection forms. The data collected from site visits, along with the material identified through literature review, will serve as the basis for developing program models which represent comprehensive and effective cooperative programs to maximize the vocational potential of handicapped youth.

FINDINGS TO DATE: The 10 exemplary programs have been selected and they have each been site visited by a team of experts in rehabilitation, vocational education, and special education. The ten programs are:

Kent Intermediate (Grand Rapids, MI)	La Grange, IL
St. Paul, MN	Manchester, CT
Cleveland, OH	Town and Country (St. Louis County), MO
Salt Lake City, UT	Houma, LA
York, SC	Bakersfield, CA

Texas Tech University

Detailed descriptions of each of these programs is now being written. In addition to these program descriptions and a state-of-the-art review of career education at the secondary level, the final report will include: a history of the federal legislation; an analysis of state laws and regulations related to cooperative programs; and an analysis of the 100 programs nominated as meeting the criteria of the project. The final report should be ready for distribution sometime in January, 1980.

APPLICABILITY: Interagency linkages are a priority in RSA research and evaluation objectives. This project should provide guidance to vocational rehabilitation agencies as to how they can work most effectively with public schools and other community agencies to provide vocationally-oriented training and experiences to handicapped youth. This project is particularly timely in view of recent legislation in vocational rehabilitation and in education which has altered the missions and responsibilities of both and which requires a reshaping of cooperative relationships between agencies.

265 Applications of Behavioral Training Strategies with the Mentally Retarded in Sheltered Work Settings

Principal Investigator:	Andrew S. Martin, Ph.D.	
Status:	Continuing	
Dates:	June 1978-May 1980	
Cost:	Annual \$34,759 RT Annual \$28,441	Projected Total \$67,919 RT % of Annual Total 81%
Annual Report Reference:	#8, Page 44, R-45	

OBJECTIVES: The general objectives of this program are to apply techniques developed in more closely controlled laboratory-like training situations to less controlled settings. The techniques to be applied involve goal setting and progress feedback to train specific job skills and generalizable work adjustment and work ethic attitudes and habits in severely retarded clients at the Lubbock MH/MR facility. These techniques have been shown to be effective with small groups of clients who work in a training laboratory established by R&T Center researchers at the Lubbock State School.

The next logical step in this work appears to be the adaptation of the findings of this work to a full-sized, ongoing sheltered work/training environment as part of the habilitation process for the retarded clients in the workshop.

METHODOLOGY: It may be said that many clients lack a "functional work ethic" and, therefore, have no real reason or motivation to work. Thus, many clients do not continue to perform well after they have been trained on a particular job or task, which often leads to an increase in off-task, distracting behaviors.

The researchers have identified three components of a functional work ethic which seem to be necessary prerequisites for independent functioning in work settings. Briefly, these are:

1. A concept of work as a remunerative activity. The retarded client must have a concept of the relationship between work and play.
2. Money must be established as a strong secondary reinforcer which has been referred to as the "buying power of money." The client must want to acquire money, for whatever reason.
3. A work history in which a person has been reinforced for working in situations in which the job or task is well defined and the compensation rate is known to the worker. A work history is differentiated from a labor history in which the "job" may be ill defined and in which compensation is either lacking or not tied to specific task performance.

The first cooperatively planned study in the series which was conducted at the Lubbock MH/MR Center, involved six mentally retarded clients ranging in age from 23 to 38 with a mean IQ of 36 (range 15-46).

All of the clients for this study were selected by workshop personnel at the request of the experimenters who asked that the trainers select a group of clients who "didn't have any concept of working, or what they were supposed to be doing in the workshop."

At the time the study began, the clients were paid (as were all clients in the workshop) by check once a month. Observation of the clients in the study and other clients in the workshop revealed that the paychecks seemed to be highly reinforcing, but conversations with the clients (including the ones to be included in the study) kept raising the question—reinforcing what? Clients seemed to be just as content with a check for \$2.00 as with one for \$50.00, and continued observation seemed to confirm the hypotheses that the act of getting a paycheck was reinforcing in the social context of everyone getting a check, but that it was not perceived as compensation for the number of units assembled in the preceding thirty-day period.

The study involved alternating baseline conditions as they had existed in the workshop for about 2 years and training conditions in an ABAB design. During the initial baseline condition, clients were paid once a month by check, and experimenters did nothing more than record time spent working and collect production data.

Feedback and the forming of a direct link between work behavior and paychecks were accomplished by tallying production twice each day and placing accumulated earnings in clear plexiglas tubes placed in front of each client. The method of calculating paychecks was altered in that the amount of each client's check was fixed at the amount of coins (nickels) contained in a full tube, and clients were instructed that they would "earn" a paycheck when their tube was filled. When a client filled the tube, the coins were emptied, and traded for a paycheck.

The first training phase lasted for nine weeks. The second baseline was a return to the same conditions as the first baseline in that clients got no daily feedback, and returned to regular monthly paychecks. The second training condition reinstated the coin tubes and the ratio paychecks. The second baseline and second training condition each lasted eight weeks.

Because this project is a cooperative effort with sheltered workshops, future studies are geared to be responsive to training needs; therefore, specific methodologies cannot be detailed at this time. However, they will be aimed at creating stable relationships in work settings and investigating training techniques which will produce durable and generalizable work habits.

FINDINGS TO DATE: One study in this programmatic effort was completed during the year. The design and procedure for the first study are described in some detail in the methodology section of this report. The results show a statistically significant 14.5% increase in production from the initial baseline to the first training phase. There was a slight drop in production at the beginning of the second baseline, but after about 3 weeks all clients began to show an increase in production which continued throughout the rest of the second baseline, and by the end of the second baseline, were producing 8% greater than in the first training phase and 22% above initial baseline. Clients made a mean 16% increase from the first half to the last half of the second baseline. The beginning of the increase during the second baseline phase corresponded with the receipt of the first monthly paycheck, and one more paycheck was received during this eight-week baseline phase. The causal connection is only speculative at the present. The second training phase was initiated in order to try to capitalize on and stabilize the increasing production seen in the last half of the second baseline. An additional 2% increase over the last half of the second baseline was realized and maintained until the end of the study which terminated eight weeks into the second training phase with a change in production methods in the workshop. During the approximately eight months of this study, clients gained and maintained a mean 24% increase in production. The overall gains for each of the 6 clients were 65%, 26%, -2%, 16%, 7%, and 35%.

The data of most relevance to the hypotheses under investigation is the increase in production during the second baseline condition, which should have constituted an extinction phase if the daily feedback and social reinforcement were the factors maintaining production increases during the first training phase. It is impossible that this upswing in performance reflected a delayed internalization of a work ethic, although this is only speculative.

The authors conclude from the results obtained in this study that it is desirable and feasible to train the relationships which exist in work environments and which we may take for granted, but which are probably more important in **maintaining** work skill training than that training itself.

APPLICABILITY: This study seeks to extend the findings from previous laboratory research on goal setting and the development of a work ethic to an actual sheltered workshop for the mentally retarded. In essence, the purpose of the present study is to test the generalizability of techniques found to be of value in increasing and maintaining work performance of mentally retarded clients. Previous research has shown that moderately and even severely retarded clients can acquire relatively complex skills in a laboratory setting but that productivity often deteriorates in an actual workshop setting. Earlier research has demonstrated successful techniques for maintaining behavior in isolated, laboratory simulations of workshops. It is not known at this time if previous findings are valid in real workshops where there may be much more distraction and less control of the environment by the supervisor. Techniques which are found to be successful in maintaining skills acquired in training could be utilized to keep production rates high and possibly to reduce or eliminate workshop problems such as off-task behavior, client disturbances, and absenteeism. In addition, the project may lead to the development of additional techniques aimed at solving frequently encountered problems in a sheltered workshop.

266 Predicting Future Trends in Rehabilitation of Mentally Retarded Persons

Principal Investigator:	J.D. Parham, Ph.D.	
Status:	New	
Dates:	September 1978-August 1979	
Cost:	Annual \$13,620 RT Annual \$11,299	Projected Total \$13,620 RT % of Annual Total 83%
Annual Report Reference:	#8, Page 140, R-46	

OBJECTIVES:

1. To establish, with help from leaders in the field, a prioritized list of possible new trends in rehabilitation of mentally retarded people.
2. To provide a data base for forward planning of continuing or career education for rehabilitationists.
3. To prioritize training needs for future rehabilitationists.
4. To provide data for establishing timelines for preparing to meet new manpower needs.
5. To identify priority directions for future research.

METHODOLOGY: A modified version of the Delphi technique will be used for this study. Essentially, the Delphi technique is a series of questionnaires interspersed with opinion feedback. Typically, the method for conducting a study involves sending questionnaires in rounds to individual panel members after a preliminary letter has been sent inviting them to participate. In this study a preliminary letter will be sent to influential individuals involved in policy issues asking them for responses to a questionnaire/outline. Their responses will assist the researchers in formulating areas of investigation for the Delphi study. A letter will then be sent to persons identified as experts in vocational rehabilitation services for the mentally retarded, asking them to participate. These panel members will consist of people from the following groups:

1. Specialists in mental retardation and/or training in state vocational rehabilitation agencies.
2. Staff at the three Research and Training Centers in Mental Retardation.
3. Rehabilitation educators and/or other university or community experts.

If they agree to serve, the experts will be asked to respond to a first round questionnaire concerning future trends with regard to: (a) social attitudes, (b) utilization of support personnel, (c) legislation, and (d) economics. The responses to the round one questionnaire/outline will help the staff in developing the open-ended statements in these areas, and possibly highlight other areas. Combining these responses through a process of screening, these statements will be reduced for round two. In round two, those participants who responded to round one will be asked to rate each of the factors on a seven-point continuum from least important to most important. At the end of round two, the mean for each factor under each of the six basic content areas will be placed in rank order. The result is a priority ranking which has a variety of uses. (Hopkins, 1972; Skuttsch, 1973; Weaver, 1972).

In round three, those members of the population who responded to round two will be asked to agree or disagree with the panel's rankings, stating their reason for any disagreement. These predictions (agreements regarding perspectives of the future) along with the rationales regarding alternative possible futures (disagreements) will be condensed to form a picture of the complications of various alternatives. From this data, staff will also generate specific recommendations for training and factors to consider regarding alternative decisions and their anticipated consequences.

FINDINGS TO DATE: The preliminary step to seek input from those influential in setting policy was directed at a relatively few individuals involved in policy at the national level. Four of these individuals returned the questionnaire/outline; some excellent input was received; and, in general, the responses reflected areas of concern that were along the same lines that the research team felt might be important. More specifically, the concerns were in areas such as: personnel needs, preservice and inservice training, legislation, litigation, and current trends toward community treatment and resultant changes; and other areas of concern such as interagency cooperation and effects of minimum wage laws.

After the preliminary effort to define areas of concern, sixteen panel members were selected and their participation solicited. Having received their positive responses to participate, the panel members were sent round one questionnaires to complete and return. Due to the open-ended nature of this questionnaire, the responses were diverse. It would be premature at this point to give the results of this round since the move toward consensus will come in the second and third rounds.

The second round of the Delphi has been prepared and sent to the panel which now consists of fifteen members. The responses to this round have begun returning, but again it is premature to draw general conclusions from this round until more responses are returned.

APPLICABILITY: The findings of this study will be disseminated through standard publications and through short-term training programs conducted by the Research and Training Center. They will be made available in special mailing to continuing education and university related rehabilitation programs.

The findings of this project have potential use for all individuals who work with retarded persons. They should be particularly helpful to state agency counselors in evaluating and improving their performance with mentally retarded clients and to state rehabilitation agency administrators in selecting, preparing, and utilizing rehabilitation personnel for work with retarded persons. The findings of this study can also be incorporated into undergraduate and graduate rehabilitation programs and into continuing education and inservice training.

The results of this study and those of the program of research and training which it is designed to generate should have implications for the pre-service and in-service training of rehabilitation counselors and should modify the practices of counselors related to the rehabilitation-habilitation of the mentally retarded, improving service delivery to this disability group. The results should also be utilized by legislators and RSA staff for forward planning related to training priorities and legislation.

267 Program Evaluation for an Integrated Community-Based Extended Rehabilitation Service System

Principal Investigator:	J.D. Parham, Ph.D.	
Status:	New	
Dates:	September 1978-May 1981	
Cost:	Annual \$36,480 RT Annual \$23,230	Projected Total \$69,690 RT % of Annual Total 64%
Annual Report Reference:	#8, Page 150, R-47	

OBJECTIVES:

1. To document the development and growth of an integrated continuum of community-based extended rehabilitation services.

2. To develop a comprehensive program evaluation model suitable for use by a community-based integrated service delivery system.
3. To implement that model among member agencies of the community-based service system.
4. To document the implementation procedure.
5. To develop mechanisms for integrating program evaluation as a part of the ongoing management system.
6. To develop mechanisms for information feedback that have impact on program and client services.
7. To develop procedures that involve all levels of the community-based provider agency staff in the decision-making process and program evaluation.
8. To develop procedures for replication of the program evaluation and community-based models.

METHODOLOGY: The methodology of this study is designed to determine what steps are necessary and sufficient to develop a successful comprehensive community-based integrated service-delivery system for the severely disabled. One of the necessary components within such a system is an integrated and continuous process of self-evaluation. This program evaluation process would determine how well individual programs within the agency meet their goals; it would also examine the agency or system as a whole for the purpose of increasing the effectiveness of that body.

The program evaluation process must integrate both research and dissemination mechanisms. This would ensure the continuity and validity of the process; evaluative research outcome data (specifically designed to meet the needs of the system for relevant information on its effectiveness) can then be interpreted and translated into recommendations. The recommendations can be presented to the appropriate decision makers for implementation, and evaluation can be made of the effects of those implemented recommendations.

FINDINGS TO DATE: Three specific areas of interest have prompted investigation thus far, and these include: (1) consensus of board members regarding goals and objectives of LAERS, (2) impact of LAERS on the ERS clients served, and (3) changes in LAERS clients as perceived by their families.

The questionnaires used to assess board members revealed a strong commitment to establish and upgrade sheltered work facilities and a general agreement that program planning was deficit. A large part of the organization's problems were attributed to a lack of interagency communication and coordination. All of the board members agreed that LAERS was fulfilling a vital community function and was a worthwhile project. One additional factor became apparent as a result of open-ended questioning, and that is the importance of public relations and the maintenance of a visible profile in the community.

The impact of LAERS program on the clients was measured by means of analyzing a small number of cost benefit factors. Covering the first year of operations, these were simply reported in terms of frequency and percentage rates. Overall, results indicated an average increase in per capita income which in turn served to decrease the amount of subsidy provided by LAERS funds and sheltered work facilities. The clients also showed rather marked increases in number of hours worked during the year.

Many of the results reported above were reflected in the parent's observations of the LAERS clients. Fifty percent of the sample clients had begun to pay rent and reimburse their families for food. A majority of the clients were purchasing many of their own clothes and personal items. As a result, a number of the parents reported noticeable increases in self-confidence and pride in that the clients were feeling more self-sufficient. The client also felt more useful and motivated to work.

Other information gathered during this process covered cost to the families of maintaining the clients and cost-benefit factors relevant to LAERS as an organization.

APPLICABILITY: The first phase of results have been disseminated to members of the LAERS board and have precipitated consideration of a number of issues which heretofore had been generally taken for granted. The final results will be particularly helpful to the consortium agencies of LAERS and to federal and state planners entertaining the concept of cooperative community services.

268 Increasing Parent and Caretaker Effectiveness in Understanding and Dealing with the Sexual Development of the Retarded

Principal Investigator:	Susan F. Elias, Ed.D.	
Status:	New	
Dates:	June 1978-May 1980	
Cost:	Annual \$35,550 RT Annual \$27,600	Projected Total \$71,100 RT % of Annual Total 78%
Annual Report Reference:	#8, Page 273, R-48	

OBJECTIVES

1. To demonstrate a need for and benefits to be derived from sex education programs for parents and caretakers of retarded people.
2. To assess the needs and/or problems associated with sexuality of retarded people as viewed by parents and the personnel of schools and institutions serving retarded children, adolescents, and adults.
3. To elicit parent and caretaker involvement in establishing guidelines for sex education programs and materials for other parents and professionals.
4. To establish a flexible format for sex education programs for parents and caretakers of retarded individuals.
5. To conduct a series of sex-education workshops for parents and caretakers of retarded individuals.
6. To conduct improvement-oriented evaluation of the workshops for parents and professionals, according to the following criteria: (a) client satisfaction with the program, (b) attitude change, (c) increased knowledge regarding sexuality and the retarded, (d) increased confidence and competence in dealing with sexuality of retarded individuals, (e) changes in parent and caretaker handling of sexual development and problems of retarded children, adolescents, and young adults, and (f) changes in mentally retarded students' knowledge and attitudes regarding sexuality.

METHODOLOGY: A written survey of concerns and perceived needs and problem areas with respect to sexuality of the mentally handicapped was given to parents, professionals, paraprofessionals, and teachers in special education or rehabilitation. The results of this survey served as guidelines in developing the workshop program. In conjunction with the survey, respondents were asked to indicate their interest in participating in the sex education workshop.

At the present time, workshops have been conducted for professionals in rehabilitation, for teachers in special education, and for staff members of a residential institution. All participants were asked to complete several assessment measures, including a dating scale assessing attitudes toward dating behavior of retarded individuals, a survey of knowledge and beliefs about the sexuality of the retarded, a questionnaire on feelings of confidence in dealing with the sexuality of retarded people, and a questionnaire which ascertains how sexual problems are typically handled by the respondents, both prior to participation in the workshop and immediately following the last session of the workshop. Control groups consisting of individuals with similar professional backgrounds as the participants also completed the pre- and post-assessment measures, while they did not take part in the workshops.

The workshop program itself consists of presentations as well as small group discussion meetings and question and answer sessions. Dramatic play (pantomime, improvisation, and role playing) are used to provide practice in dealing with difficult or problem situations. Time is set aside for materials evaluation and incorporating available materials into an organized curriculum for retarded individuals.

Topics covered in the workshop sessions are: (a) introductory material on the physiology of sex, (b) attitudes toward sexuality in general, (c) attitudes about retarded individuals as sexual beings, (d) social and marital potentials and limitations, (e) fears and anxieties of parents and

caretakers over sexual behavior, and (f) methods of communicating constructively with retarded people in this area.

The independent variable of major interest is the workshop program. Dependent variables include trainee satisfaction with the program, changes in attitudes toward sexuality and retarded individuals, increased knowledge of sexuality and the retarded, and changes in parent, professional, and paraprofessional handling of sexual development and problems.

FINDINGS TO DATE: A preliminary analysis of the initial survey given to 190 staff members of a residential institution led to some interesting findings. Ninety-four percent of the respondents believed that sexual behavior represents a problem area in caring for retarded individuals, and 93% said they thought sex education for retarded persons is as necessary or more necessary than it is for "normal" people. Yet, 55% responded that they had given no sex education to the residents, and only 3% had ever started discussions about sex with the residents. Sixty-five percent claimed they dealt with sexual problems as they arose, but 14% said they did nothing at all, only 5% had any clear guidelines for responding to sexual problems. The gap between recognition of the need for sex education and the hesitation to actively take a part in the sex education of residents may be due at least in part to a feeling of being unprepared. Twenty-nine percent of the respondents felt they did not have enough knowledge of sexual functioning, and 33% did not feel prepared enough to give the residents sexual information. Eighty-nine percent of the respondents said they would be interested in taking part in a workshop on how to talk and communicate better with the residents about sexuality.

Analyses of the pre- and post-assessment data have not been completed at this time. However, the results of evaluation forms completed by workshop participants have been examined. The following scores were obtained from the 6-point scale with 1 being the most favorable response (strongly agree) and 6 being the least favorable response (strongly disagree):

I really enjoyed attending this workshop - 2.42
I feel more comfortable talking about sexuality - 2.58
The material was presented very effectively - 2.38
The workshop was very well organized - 2.19
I plan to apply what I learned in my work - 2.19

In response to some additional questions, 71% of the participants reported that the workshop had been worth the time invested, and 67% said that they definitely would recommend the workshop to other professionals and parents, and an additional 22% said that they probably would recommend the workshop to others. While only 57% believed their attitudes had changed as a result of the workshop, many of those who said their attitudes had not changed reported that their attitudes and feelings had been clarified by attending the workshop session. Many of the participants reported that they had increased their knowledge in the area of human sexuality, and a majority of those who said their attitudes had changed mentioned finding it easier to talk to clients about sexuality.

These preliminary findings indicate that the workshop program has been a positive experience for most of the participants. The feedback suggests that by the end of the workshop, participants feel better prepared and more comfortable about dealing with the sexual development, growth, concerns and problems of their clients. Hopefully, a more extensive analysis of the information provided by pre- and post-measures will further support the suggestion that the sex education workshops have had the desired effects of increased awareness of retarded people as sexual human beings, greater comfort in dealing with sexuality, and increased knowledge of practical approaches to sex education for mentally handicapped individuals.

APPLICABILITY: Retarded individuals capable of using the recreational and vocational resources of a community and living in independent or semi-independent housing must have a basic and practical knowledge of sexuality if they are to be expected to behave responsibly in the sexual realm. The mentally handicapped are not likely to make a successful adjustment to the community or to their work situation if their sexual behavior is inappropriate and therefore socially unacceptable.

However, parents and caretakers have tended to be extremely overprotective with respect to the sexuality and their charges. At the same time, parents and professionals recognize that the overprotective approach is generally not effective in preventing sexual problems, and they have

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begun to request materials and training to help them in an area which makes them uncomfortable. It is hoped that through educating the parents and the professionals who most frequently interact with mentally retarded youngsters and adults, the mentally handicapped may be better prepared for sexual responsibility and more adequate adjustment to community life as adults.



**University of Wisconsin-Stout (RT-22)
Vocational Rehabilitation Research and Training Center**

CORE AREA

Vocational Evaluation

The development and dissemination of new knowledge in vocational evaluation and the client service areas interfacing with vocational evaluation, (which include work adjustment, vocational training, follow-up and counselor/client decision making), and also the development of demonstration programs in the areas of client referral to vocational facilities and effective facility service utilization.

UNIVERSITY OF WISCONSIN-STOUT

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COMPLETED

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269 The Effects of Vocational Evaluation on Client Vocational Awareness, Attitude, and Competency

Principal Investigator: Fredrick E. Menz, Ph.D.
Status: Completed
Dates: September 1974-May 1978
Cost: Annual \$5,776 Projected Total \$34,000
RT Annual \$4,219 RT % of Annual Total 73%
Annual Report Reference: #7, Page 69, R-23

OBJECTIVE: The Wisconsin Division of Vocational Rehabilitation has set up a demonstration project entitled Concentrated Assessment and Diagnosis in Rehabilitation Entrance at the Waukesha Office. This project was conducted to determine the advantages of early assessment of the severely disabled in their rehabilitation. Consistent with this objective were aims which included reduction in costs for and improved quality of evaluation and more effective utilization of community resources. The focus of the project was on reducing the time delay between referral for evaluation and assessment of clients by basing a Singer Vocational Evaluation System in the office. The Center's research role in this was to determine the immediate effects of vocational evaluation on client vocational orientation.

METHODOLOGY:

1. **Samples:** Samples for this study include all counselors at the Waukesha office and all clients entering the Waukesha office between December 19, 1974 and March 1, 1976 and referred for vocational evaluation.

Counselors provided ratings on behaviors of all clients referred to vocational evaluation during this period. Counselor referrals were "natural," i.e., no attempt was made to impose structure on the referral process. Both estimates of client functioning and direct measures of their vocational attitudes and competencies were obtained on all clients.

2. **Variables:** Client demographic variables as sex, disability, referral source, funds expended, and risk group classification were collected from office records. Counselor demographic variables as sex, experience, and referral patterns were also collected for descriptive purposes.

The dependent variables were client vocational awareness, client vocational attitude, and client vocational competency as measured by a goal attainment scale and the Career Maturity Inventory (CMI).

3. **Procedures:** At referral, counselors ranked each awareness area in terms of its relative importance as a desired effect of vocational evaluation on the client. Immediately after the counselor's first contact with the client subsequent to vocational evaluation and prior to receiving the evaluation report, the counselor rated the client's functioning in each awareness area. If the client was referred to the office-based evaluation, the evaluator also independently estimated the client's level of functioning in each area.

The effects of vocational evaluation on client attitude and competency were estimated in a "separate sample pretest-post-test design." Clients referred to the office-based unit were randomly assigned to a pre- or post-testing with the CMI.

Demographic data on clients and counselors were employed in the analysis of the data collected on clients referred to vocational evaluation to most adequately explain measured effects.

FINDINGS TO DATE:

CADRE Program Structure

The evaluation unit served between 1 and 7 clients per week over a 42 week period. The typical number served each week was between 2 and 4 clients with a rough median client-evaluator ratio of 3:1. Sixty-nine percent of the clients referred for the service were males and 31% females and all were in the service between 1 and 10.5 days. Most typically, the service duration was 4.5 days and very rarely lasted more than 6 days. Eighty percent of those referred to evaluation completed, with 16% dropping out prior to completion, and only 4% reported as not having shown up

once the referral contact was established.

During the evaluation, 71% were able to identify at least one job that they had had and liked, with 62% identifying 1-2 jobs, and 9% identifying 3-5 jobs. In all, 64% of them could also state at least one thing about the job which caused them to say that they liked the job. When asked whether there was work which they would have confidence in their ability to do, 24% could not identify any such work, while 18% could identify 3 or more types of jobs, and another 58% could identify at least one job.

In the previous five years, 43% of the clients had not held jobs, while 45% had held at least one, and 12% had between 2 and 3 different jobs. This high percent of unemployment, however, is partially reflected in the fact that 31% were still in school, 32% had left school before they were 18, and 55% of the group were planning further schooling or training.

Weschler intelligence scores and WRAT reading and arithmetic scores were available for a high proportion of the clients. Cognitively, the client had higher functioning than is generally found in vocational evaluation services, but were functionally ill-prepared in literacy and computational skills.

The general evaluation included combinations of aptitude, interest, and personality inventories, and various combinations of the 16 Singer evaluation units based upon the evaluator's decision.

Effects of Vocational Evaluation

In the evaluation of the effects of a two-week vocational evaluation service on adolescents, Mueller and Menz (1976) administered the Career Maturity Inventory to the students prior to beginning evaluation and immediately after. In that study, highly significant ($p < .01$) improvement in student attitudes toward entry into the world of work occurred, along with a general tendency ($p < .10$) for them to improve their abilities to plan entry into the world of work, formulate and select vocational goals, solve problems related to school and career choice, and appraise their own vocational and educational capacities.

The present study attempted to determine whether such findings would be obtained with a typical rehabilitation group in a service of shorter duration. The CADRE evaluation was essentially an abbreviated form of the evaluation which the adolescents in the Mueller and Menz study had received. There were no changes in client vocational attitude or competencies as a result of the 4.5 day evaluation. A short screening type evaluation does not produce significant changes in clients along these dimensions.

Dunn & Korn (1973) studied the effects of vocational evaluation on youthful offenders using a goal attainment scale similar to that employed in the present study. They found that clients demonstrated awareness of present vocational goals at the expected level, but over all five goal areas their attainment was consistently at the "less than expected" level. Client awareness was an expectation in the CADRE program and a goal attainment scale was completed by counselors and evaluators on a couple of the clients.

On the basis of mean ratings provided by counselors and the evaluator, these clients do not seem to be "aware" of the services they need and of their vocational qualifications and potential. Counselor and evaluator both, however, see them as aware of their vocational interests or vocational goals. These preliminary findings are similar to those found by Dunn and Korn with youthful offenders who received a two week evaluation.

APPLICABILITY: The findings of this study document the immediate client effects of vocational evaluation.

With the increased concern for provision of adequate services in a timely fashion to the handicapped, the simultaneous concern has been clearly stated in the legislation that the effects of rehabilitation services must also be determined. This need for evaluation of rehabilitation services raises the issues of measurement of expected outcomes of the services. The findings of this study are applicable to both issues. They address the issue of what immediate effects should be expected from vocational evaluation. Such results in turn should be valuable to program planners, managers, and practitioners in better utilization of services toward the end of client benefit.

270 Telecommunications in Training of Rehabilitation Facility Personnel

Principal Investigator: Charles C. Coker, Ph.D.
Status: Completed
Dates: September 1975-June 1978
Cost: Annual \$11,563
RT Annual \$8,437
Projected Total \$45,000
RT % of Annual Total 73%
Annual Report Reference: #7, Page 245, R-24

OBJECTIVES: This project's purpose is the developmental and implementation of an innovative technique to enhance the training and research of the Center. The objectives are to determine: a) the availability and costs of telecommunications systems or equipment most compatible with the training and/or research needs of the Center. b) Potential and actual benefits to training and research of the Center.

METHODOLOGY: The mechanics of the project consists of three phases:

1. Planning Factors — Determining telecommunication systems and equipment costs, advantages, disadvantages, and Center needs.
2. Demonstration Factors — Site arrangements, training material selection, and evaluation of training via telecommunication.
3. Implementation Factors — Cost/benefit analysis based on Phase I & II to determine optimal system for Center needs.

FINDINGS TO DATE: This demonstration project was conducted to determine the most feasible method of enhancing the Center's training of rehabilitation personnel through the use of telecommunications equipment.

The method of telecommunication which we were interested in establishing needed to have the following characteristics:

1. Maximize the interaction between the trainer and the trainee.
2. Maximize flexibility for conducting telecommunications in terms of minimizing the length of time between decision to conduct such training and actual conduct of training; with no restrictions on frequency or regularity of such training.
3. Flexible to the size of group (i.e., 2-40 or more).
4. Be cost-effective in terms of minimizing equipment cost and transmission cost.
5. Minimum restriction on location.

None of the University of Wisconsin's telecommunication systems would allow the RTC to be responsive to facility and state agency needs for our type of short-term training.

Equipment:

1. One-way telephone amplifiers. Difficulty: Amplifies incoming voice only.
2. Two-way telephone amplifier.
 - a. Model FTA-100 (Fanon/Courier Corporation, Pasadena, CA). This unit is the only two-way voice, cradle type amplifier we could find on the market. Attractively designed cradle type voice amplifier with reasonably good quality, but only moderate voice amplification. Power supplied by 12 volt, AC, DC adaptor. Major advantage is that it requires no electrical hook-up to the telephone. (Advertised regular price: \$99.95; purchased from Allied Electronics for \$49.95, were still available as of January 1979.)
 - b. Portable Conference Telephone from Western Electric-Bell Telephone. These units offer two-way voice amplification through direct attachment to the electrical telephone line. Two portable mikes are provided as well as a mike in the set for picking up several voices. Quality and intensity of this unit is superior to the model FTA-100 above. This equipment is installed by, and rented from the telephone company. (One cost quote was \$52.25 for installation and \$11.49 per month rent.) Major disadvantage is cost of installing and renting.

- c. Darome Model 610A Convener from Darome, Harvard, IL. This unit is a two-voice amplifier which requires direct electrical connection to the telephone lines. Unlike the telephone equipment, the regular telephone must also be connected. The Darome appeared superior to the units above in terms of the quality, intensity, and flexibility to add external mikes. (Cost of the Darome unit with one mike was \$390.00 in May of 1978.)

Software: Teleconference training would appear to be best suited for follow-up training to the Center's regular training program offered with the trainers on-site. Basically, it was concluded that teleconference training is not equally effective for short-term training as compared to on-site. The reasons for this appear to be:

1. Short-term training, by nature, involves the presentation of a great deal of new material in a short period of time.
2. The short-term trainers' ability to "sell" the new information to trainees is an important aspect of the assimilation of the material.
3. Presentation of a new material requires more than a voice to voice dialogue. Audiovisual presentation increases the understanding of the new material.
4. The interaction between trainers and trainees is diminished, due to the requirements for ordering verbal exchanges in teleconference training (i.e., speakers need to identify themselves and wait when others are talking.) Also, long dialogues on the Darome unit are difficult to interrupt at times, due to equipment design.
5. It is much more difficult for the trainer to "read" the trainee audience and adjust training accordingly.
6. Low trainee respondents tend to get easily bored and more reluctant to respond.

Despite the limitations of this study, teleconferencing can enhance the accessibility of the Center's training resources to rehabilitation facility personnel. The Center's teleconference training capabilities would take several forms, depending on the needs of the facility and the nature of the training:

- a. One to one phone dialogues with single individuals.
- b. Teleconference with one-two individuals in different locations.
- c. Teleconference with groups of individuals in different settings.
- d. Teleconference with one large group in one setting.
- e. Teleconference adjunct training to regular on-site training where specialized expertise is added to the current training services.

The project has now been terminated with the successful addition of teleconference follow-up training (a-d) and the enhancement of current training programs through presentation of guest lecturers from remote locations (e).

APPLICABILITY: The need for an economical method for providing short-term training and other staff development activities to rehabilitation facility and state agency personnel is self evident. Telecommunications technology offers a way of providing a personal link between trainers and trainees while avoiding excessive travel costs and energy consumption. Through the use of conference call capabilities, it literally allows trainers to be in several places at once, thus increasing their utilization and making their expertise more widely available.

The findings will be used primarily by trainers and staff development personnel. The application of telecommunications technology may be an effective and economical means of providing short-term and in-service training to rehabilitation personnel in diverse geographical areas. There are several possible spin-off applications, one of which involves the more effective use of consultants. It is often desirable to obtain consultation on a very specific topic either as part of a training program or in planning and program review. Telecommunications may be applied as a means of securing short (one or two hours) consultations on these topics. This would make better use of existing expertise at a lower cost.

271 Development of a Competency-Based Staff Development Program for Vocational Evaluators

Principal Investigator: Darrell D. Coffey, Ed.D.
Status: Completed
Dates: July 1975-June 1976
Cost: Annual \$20,236 Projected Total \$55,000
RT Annual \$14,766 RT % of Annual Total 73%
Annual Report Reference: #7, Page 251, R-25

OBJECTIVES: The study is directed toward assessing the competency needs and levels of vocational evaluators to provide quality services to the handicapped. The objectives are as follows:

1. To coordinate action with various professional groups and training/education facilities to provide input into the project's design and relevancy, to avoid duplication of effort and to disseminate project's findings.
2. To ascertain competency statements which reflect the task requirements of the vocational evaluation.
3. To determine the relative importance of competency statements in relation to job requirements.

METHODOLOGY: The procedure involves devising a questionnaire containing competency statements concerning vocational evaluator job requirements, having a select sample rate the importance of these statements, analyzing data for significance and common task requirements, and repeating the procedure as necessary to refine the data for meaningful impact to training/education programs and professional groups.

FINDINGS TO DATE: An initial statement pool of over 2500 competency items has been screened and reduced to 175 competency statements relating to vocational evaluator task requirements. The statements were administered to groups of 116 rehabilitation educators, students, and practicing vocational evaluators who were asked to rate the importance of each statement and indicate where that skill could best be acquired. Biographical data was collected on each respondent and reliability checks were made on the ratings.

Most of the 175 competency statements were perceived by the respondents to be important knowledges, skills, and abilities for an entry level evaluator. Although the findings suggest the instrument may lack discriminatory power, the 175 statements were developed from an initial analysis of 2500 statements, thereby increasing the applicability of the statements directly to the skills of the vocational evaluator. Thus, it is reasonable to expect the competency statements would be perceived as important by the respondents.

Since the importance of the competency statements has been determined, continued analysis will focus on screening out the low priority statements for the purpose of analyzing the other competency statements by category or subject area and learning approaches in relation to identifying training units for staff development training.

APPLICABILITY: It is anticipated that the results of this research will be widely used by short-term and long-term training programs for rehabilitation personnel. The state VR program may expect to directly benefit from this usage since improved evaluation will be provided to clients referred to rehabilitation facilities. The availability of validated training units may also encourage the development of new training programs for facility personnel.

An additional possible application of the results of the project is the use of the assessment procedures to be developed in a competency-based certification program for evaluators. Currently there are no universally accepted "standards" for certifying these individuals, but the assessment procedures to be developed in this project will lend themselves to this purpose.

272 Effects of the Use of Different Types of Norms on the Occupational Decisions Made by Vocational Evaluators

Principal Investigator: Geraldine Hansen, Ph.D.
Status: Completed
Dates: June 1977-June 1978
Cost: Annual \$14,455 Projected Total \$58,136
RT Annual \$10,548 RT % of Annual Total 73%
Annual Report Reference #7, Page 93, R-31

OBJECTIVES:

1. To determine whether the types of norms used (client, general population, or competitive) affect the clinical judgments made by vocational evaluators about severely disabled persons with reference to a specific occupation.

It is hypothesized that making vocational recommendations (i.e., broad recommendations relative to level of employability, areas of work, worker functioning level, and service needs) is a clinical judgment process which is relatively insensitive to shifts in type of norm. It is further hypothesized that making occupational decisions (decisions regarding placeability, trainability, or non-suitability with reference to specific occupations) is an actuarial decision-making process which is sensitive to changes in type of norm: specifically, the use of competitive as opposed to client norms increases the number of "screen-out" and investigatory decisions (more information needed) made with severely disabled persons.

METHODOLOGY: In survey I, vocational information containing client, general population, or competitive norms at different levels of functioning (above average, average, or below average) were given to 76 participating vocational evaluators. The evaluators were asked to decide whether they would recommend that the client should, with respect to a specific occupation, (1) seek employment in that occupation, (2) receive training in that occupation, (3) be further evaluated in that occupation.

In Survey II, a case study containing vocational information and 1 of 9 possible combinations of norms (client, general population, or competitive) and levels of performance (above average, average, below average) was randomly sent to members of the Vocational and Work Adjustment Association. They were asked to decide whether they would recommend that the client should, with respect to a specific occupation, (1) seek employment in that occupation, (2) receive training in that occupation, (3) be further evaluated in that occupation, or (4) not be considered for that occupation.

FINDINGS TO DATE: Approximately 676 of the questionnaires were returned, of which 510 were useable. The main reason that these 166 were not used was due to incorrect responses on two questions asking what the norm type and performance level was as stated in the text of the case study. Chi-square analyses were computed using a 3 (norms) x 3 (performance levels) x 4 (type of decision) design. In general, the respondents tended **not** to make terminal decisions, as only 8% of the total number of decisions were "definitely employ" or "no potential." The majority of the respondents (92%) decided, regardless of the norm type or performance level, that the client was definitely trainable (28%) or needed further evaluation (64%).

Respondents residing in different VEWA Regions do not differ in their decision-making. Furthermore, respondents administering work samples to clients responded similarly to respondents who did not administer work samples to clients. When job titles of the respondents were compared in relation to their responses, generally all respondents made similar decisions.

The Chi-square analyses indicated that the type of norm had no effect on the decision made. The small differences that did exist were in the opposite direction of that expected, with **slightly** more clients being considered as having no potential with client norms than with other norms.

In contrast, the performance level had a statistically significant effect on decisions made ($P < .001$) and revealed a clear pattern. As the performance level **decreased**, the more investigatory decisions for further information (3) and more terminal decisions of no potential (4) **increased**. This latter finding is consistent with common sense, as it is expected that as a level

of ability decreases, the judged potential would decrease.

Since the performance level had a significant effect on the decision-making of the respondents, it must be concluded that the survey instrument did indeed assess the decision-making strategy of the respondents. If this is true, then it is also logical to conclude that norm type does **not** have an effect on the occupational decisions made about clients.

Unfortunately, the picture becomes somewhat clouded when the results of an earlier survey (Survey I) are taken into account. In Survey I, a different design was used but the content was similar to Survey II above. These 76 respondents were asked to make an occupational decision nine times about the same client using a combination of three different norm types with three different performance levels. Thus, this within design had each participant making nine repeated decisions about what was to be done with the same client. Under these conditions, norm type did have a significant effect; as did performance level.

The disparity between the two surveys is not as incompatible as would first be assumed. Most people believe that norm type does make a difference. In Survey I where nine decisions were made, it should have been obvious to the participants that this was a survey about the effects of norms on occupational decisions. Thus, it can be assumed that these participants were aware of Survey I's purpose and responded in the way that they believed norms should, in theory, affect decisions. In Survey II, only one norm type and performance level was stated in the text of the case study material, but these differed among the nine groups of participants. Though these participants had to state what norm type and level was in their case study, it is highly unlikely that they were aware that we were looking specifically at the effect different norms and performance levels have on decision outcome. We believe that the respondents (510) in the mailed survey responded as they would in practice.

Together, the two surveys, within subject (aware) group and the between subject (unaware) group would lend to the following conclusion about the effect of norms on occupational decisions: Vocational evaluators tend to believe that **in theory**, the type of norm reference for work samples should have an effect on the decision they make; but **in practice**, vocational evaluators do not make different decisions using different norm references for work samples.

The research reported here does not answer the question as to what is the most appropriate norm criterion reference for work samples. It does, however, suggest that the practicing vocational evaluator's outcome recommendations are affected very little by the norm type. Rather, these decisions are much more heavily influenced by the level of performance regardless of the norm reference group. The complete research report entitled **Effects of Norms and Client Performances on Occupational Decisions** is available from the Center.

APPLICABILITY: The importance of this project is twofold: (1) it will attempt to show that the use of "competitive norms" (which are a valued characteristic of assessment materials according to many evaluators and counselors) may produce an effect which is opposite that desired and valued by the state-federal VR program (i.e., may result in restriction of employment opportunity for the severely disabled); and (2) it will attempt to show that vocational recommendations (which are commonly used by counselors and clients for eligibility determination and program planning) are made via a clinical judgment process which is reasonably independent of the type of norm used. Hence, costly efforts to produce and develop an industrial norm may not be necessary.

Since the project topic was designated as a "critical issue" by a knowledgeable group of vocational evaluation materials developers, trainers, and service deliverers, it is anticipated that project results will be used by these and similar persons to determine the types of norms which are most suitable for use in vocational evaluation programming. Similarly, since the results should indicate possible adverse effects of using certain types of norms with severely disabled persons undergoing vocational evaluation, they can be used by policy makers and program developers at the local, state, regional, and national levels for establishing guidelines and standards for work sample norms to be used with the severely disabled. The latter could preclude faulty "screen out" and restriction of opportunity occurring with this priority group.

273 The Use of Information in Vocational Decision-Making by Disabled Persons

Principal Investigator:	Charles C. Coker, Ph.D.	
Status:	Completed	
Dates:	July 1977-June 1978	
Cost:	Annual \$11,563 RT Annual \$8,437	Projected Total \$33,000 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 97, R-32	

OBJECTIVES:

- To determine whether there are statistically significant differences between disabled and non-disabled persons in the (1) types of occupational information used for vocational decision-making and (2) number of information categories used in vocational decision-making.
- To determine whether there are statistically significant differences between different groups of disabled persons (i.e., groups defined in terms of sex, major disability types, and prior work experience) in the (1) types of occupational information used for vocational decision-making and (2) number of information categories used in vocational decision-making.
- To determine through content analysis the specific sub-categories of Type of Work, Skill/Aptitude, and Working Conditions information used by disabled persons in making vocational decisions.

METHODOLOGY: The Occupational Construct Inventory (OCI) was administered to 59 subjects who were clients entering a vocational evaluation program. The OCI consists of 15 plates in which three occupations are pictured. The subject is asked to decide in which way two of the occupations are similar and in what ways are they different from the third occupation. The responses were coded with respect to (1) Biggers (1971) classification scheme and (2) a content analysis classification scheme based on the Dictionary of Occupational Titles (DOT) and the Occupation Information System. Chi-Square analyses were used to determine differences in responding with respect to various demographic characteristics in relation to both classification schemes.

FINDINGS TO DATE: The findings indicated that there were distinct differences between the disabled and non-disabled groups in terms of the specific information used. The disabled group made more use of the Type of Work and Work Conditions categories (accounting for almost 80% of the total number of responses) and less use of the Skills/Aptitudes and Education categories. Also, little or no use of the Interests, Income, or Prestige/Status information categories was noted. There were no significant differences between the two groups in the number of different information categories used by individual subjects in making vocational decisions. The results indicated that subjects consistently used only two or three of the nine possible categories.

The results also showed significant differences between different groups of disabled individuals in terms of the specific types of information used in decision-making. Sex made a significant difference in how occupational categories were used. Females used fewer categories and gave more concrete answers than males. With sexual barriers being broken down in employment, females should be more fully aware of occupational information.

Disability groups used occupational categories differently, but not in the expected directions. Physically handicapped males did not use physical demands as heavily as other male disability groups; the mentally retarded used aptitudes less than other disability groups; physically disabled females did not respond at all to environmental characteristics; and the emotionally disabled used environmental characteristics less than other disability groups. These suggest that the handicapped need help in understanding their disability and assessing how it will affect them in an occupation.

Longer employment histories did increase the use of occupational traits for males. This indicates that persons with minimum work experience need to expand their knowledge and use of occupational information. Finally, there was no difference in the number of occupational information categories used when males and females were compared with each other.

The results of this study indicated that adult disabled persons were as limited in their use of occupational information as were the students in Biggers' (1971) study with a non-disabled 12th grade population. These findings suggest the need for developing remedial programs focusing upon information use in decision-making.

The importance of good occupational information programs cannot be over-emphasized since it may be all the assistance necessary to insure realistic occupational choices from disabled individuals who have clearly defined barriers to employment (Doeringer and Priore, 1971). Such programs may ultimately lead to improved methods and techniques for presenting information to disabled persons in a manner which can be best used by them for decision-making. By having access to and control over information gathering procedures, as the rehabilitation professional does, the disabled person can actively take part in the rehabilitation choices. Professionals and disabled individuals must work side by side in vocational planning and programming if individuality in the rehabilitation process is to fully come about and be maintained.

Additionally, the results indicated differences in information use between major disability groups. These findings provide content areas which need to be considered in program development and/or the use of existing occupational information materials. Particular disability groups were concerned with particular kinds of information and these areas should be incorporated into vocational programs to meet the needs of these groups of individuals. Work sample developers will also find the result beneficial since it indicates types of information which should be included in the orientation materials to the client prior to the administration of the work sample.

APPLICABILITY: The results of these studies on the identification of the relative importance of different types of occupational information in vocational decision-making by disabled persons may have four primary uses. First, the extent to which disabled persons are in need of specific programming to assist them in making effective use of information and the need for development of special programming focused upon information use in decision-making has been suggested in the study. Second, the findings indicate that there are differences in information use between different disability groups. Disabilities may need to be taken into account in program development and/or the use of existing occupational information materials. Third, the findings indicate some information which should be included in occupational information presentations intended for use with disabled groups. This may enable state rehabilitation agencies and rehabilitation facilities to evaluate existing print and non-print occupational information materials with respect to adequacy for use with a disabled population. Such guidelines may also serve to focus in-house development of occupational information which are most commonly used by disabled persons in decision-making. Fourth, the results may be used by work sample developers to determine types of occupational information that should be included in the orientation materials provided to the client prior to the administration of the work sample.

274 Factors Influencing Counselors Determination of Client Eligibility and Referral for Facility Services

Principal Investigator:	Fredrick E. Menz, Ph.D.	
Status:	Continuing	
Dates:	March 1977-September 1979	
Cost:	Annual \$43,364 RT Annual \$31,642	Projected Total \$97,500 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 19, R-26	

OBJECTIVES:

1. To determine whether sequence of report selection and the number of reports used ~~per se~~ have effects on counselor eligibility decisions.
2. To determine whether there is an optimal number and sequence of types of reports for efficient eligibility determination with specific client disability or rehabilitation risk groups.
3. To develop a case management training package using case simulations.

METHODOLOGY: Subjects: The subjects in this study were vocational rehabilitation counselors in Wisconsin randomly selected throughout the state and assigned to experimental packages containing three of the six case studies. Sixty-four counselors balanced across the four administrative regions (18 offices) participated in the study.

Instrument: The instrument is based on the six case files used in the Coker, et al., (1976) study. The

set of six cases presents a range of severities of disability and rehabilitation risks (as defined by Lorenz, 1973 and Scheinkman, et al., 1975). Each case contains a standard vocational rehabilitation application and a total of twenty possible informational reports (casenotes, medical reports, and consultant records). The counselor selects any reports up to the point he/she was ready to make an eligibility decision. These experimental packages (expected to be useable as a training package) present all case materials in a casefile format and follow basic principles of programmed learning to maximize consistency of the experimental conditions and efficiency of data collection.

The recording format gathered data with respect to eligibility decision; number of information choices; specific types and sequence of information chosen; and estimated probability of rehabilitation success. Additional data were gathered on the counselors plan for the applicant's rehabilitation; the counselor's perceptions of factors influencing the applicant's rehabilitation; counselor experience, education and preparation; present caseload; and administrative policies and constraints under which the counselor functions.

Procedures: The experimental packages were administered during site visits to each office by the principal investigator. Each of the fourteen packages contained three of the six cases, crossed by severity of the "applicant's" disability and rehabilitation risk and balanced by order in which cases were processed. Assignment of packages was monitored to insure that at least one counselor completed one of the fourteen combinations in each administrative area and that at least thirty-two counselors completed each case. These procedures to assign subjects to case combinations allowed collection of all data needed to address the research objectives. A survey of the participants, after providing them feedback on their performance, acquired evaluative data needed to translate and refine the packages for training purposes.

Rates of acceptance (percents) of each case for rehabilitation were computed and compared with rates obtained in earlier research conducted by the Center in 1973 to determine the comparability of counselor responses to simulations between states and over time. The rates of acceptance between administrative regions within Wisconsin were examined to determine whether client acceptance for rehabilitation differs in urban and rural settings.

Both analyses of variance and discriminant functions were computed with the data on information selected to determine whether counselors use different amounts and types of information with different severity and risk groups, when making different decisions about eligibility, and if the counselor is functioning in different administrative regions of the state. The four factors in the basic analysis of variance design used with the sets of independent variables were Severity of Applicant's Disability, Rehabilitation Risk, Administrative Region, and Eligibility Decision (2x3x4x2 factorial). Where main or interactive effects were found under this design, discriminant functions were computed to isolate the interrelationships among dependent variables which contributed to distinguishing between levels on the independent variable(s).

The three sets of dependent variables analyzed were the total number of reports selected to reach a decision; the total numbers of medical consultant reports, nonmedical consultant reports, and applicant contacts used; and the relative emphases given to different sources of information. This last set of dependent variables was constructed by classifying the twenty reports as to their purposes in decision-making: Screening for physical disability (General Medical); Estimating severity of primary disability (appropriate consultant report(s)); estimating secondary medical aspects of disability (other medical consultant reports); estimating psychosocial aspects of disability (psychological and social histories); estimating vocational potential (vocational evaluation report and employment history); clinical screening and evaluation of potential to benefit from rehabilitation (casenotes); and other (educational history). Frequencies of selection were adjusted, within each of the seven classes, by availability for selection.

FINDINGS TO DATE: Analyses of how information is used in eligibility determination are still underway.

Comparability with Previous Simulation Research:

1. Acceptance of applicants for rehabilitation by Iowa and Wisconsin counselors was found to be quite consistent when examined across the six cases (79% vs. 82%) and rates did not differ by more than 7% and usually by only 2 or 3% when rates of acceptance for each case were compared. Greater variability in acceptance was found among the four administrative regions in Wisconsin than between the two states.

2. The average number of pieces of information selected by Iowa and Wisconsin counselors was also fairly consistent (7.09 in Iowa vs. 6.99, including the application for services in Wisconsin).
3. Counselors in the two states (and over the five years between the studies) respond similarly to case simulations, are similar to each other in terms of the amount of information they use to make an eligibility decision, and the data collected from them should convey a fairly accurate picture of counselor use of information (the types available in the simulation package) to reach an eligibility decision.

Counselor Use of Information in Eligibility Determination:

1. The total number of pieces of information selected in eligibility determination is unrelated to the severity of applicant's disability, the rehabilitation risk involved, and whether the applicant is accepted for services. Differences, however, were found between the four administrative regions of the state. These differences are with respect to the numbers of contacts which counselors prefer to have with the applicant before arriving at a decision. If the counselor was in the northern, more rural and less heavily populated, regions they preferred having 1.053 more contacts with the applicant than counselors in the southern and more urban regions of the state. Throughout the state, counselors select an average 2.245 medical consultant reports and 1.734 nonmedical consultant reports.
2. Severity of the applicant's disability *per se*, is unrelated to the numbers of medical consultant reports, nonmedical consultant reports and contact with the applicant used. Rehabilitation risk and severity, in interaction with risk, though, do account for significant amounts of variance. Greater use of applicant contacts and rather equal use of medical and nonmedical resources will be made with a high and low risk applicant. With a medium risk applicant, however, more reliance will be made on medical resources and less reliance on both nonmedical reports and on applicant contacts. With respect to the numbers of each resource used the High Risk Non-severely (HNS) disabled and the Medium Risk Severely Disabled (MS) applicant present contrasting problems for the counselor in his/her decision-making as reflected in their use of medical resources and casenotes. With the HNS, more direct contact is sought and less use of consultant resources is made, while with the MS, greater numbers of medical (2.391) and nonmedical (1.969) consultant reports are drawn upon.
3. Based upon the comparative emphases counselors give to different classes of information, counselors make eligibility decisions regarding four distinct types of applicants: Nonseverely Disabled (NS); Severely Disabled (S); Medium Risk Severely Disabled (MS); and High Risk Non-severely Disabled (HNS).
4. The NS applicant presents the most uncomplicated type of applicant. Major emphasis is given to determining the extent of a primary or presence of a secondary disability, along with a fairly low level or modest screening of the applicant's social, psychological and vocational background. This approach is apparently geared toward determining whether some clear and direct benefits might be accrued from rehabilitation should the applicant be accepted.
5. The S applicant presents a more variable challenge to the counselor depending on whether the applicant is high or low risk. Major emphasis is given to determining the severity of the presenting disability, regardless, but a somewhat more intense inquiry process is involved if the applicant is also high risk. More emphasis will also be given with this high risk client to determining both secondary psychosocial aspects of disability and whether the applicant has a clear vocational potential.
6. The MS represents the most typical rehabilitation applicant/client. The applicant's disability can be determined through a general medical screening. Moderate attention is given to determining the degree of severity and/or other related medical conditions along with a fairly equal attention to investigating other aspects of the applicant's background which might be related to a disability or the applicant's vocational potential.
7. The HNS applicant presents the most dramatically different problem for the counselor in selecting and processing information in eligibility determination. The HNS applicant is least likely to be accepted for services. It is with the HNS that the counselor's efforts are most clearly directed at determining whether there is some severe disability. Comparatively higher emphases are given to both physical and psychosocial aspects of disability. Reliance on consultant resources will be greatest and most variable with this applicant type.

8. For all four types of applicants, general screening for physical disability is given higher emphasis and clinical evaluation and screening for potential to benefit from rehabilitation is given modest emphasis.

APPLICABILITY: The results of this project are anticipated to have one of the following uses: (1) the determination of guidelines for assessment and eligibility determination with specific client groups which could be used to establish case review standards; (2) the determination of critical report content which could be used to establish guidelines for preparing reports as well as performance evaluation of professional consultants; (3) the determination of the types of biases which occur in making referrals and preparing reports which could be used to develop guidelines for referral and report writing.

Additionally, the results will provide basic information regarding the eligibility determination process which can be used in both pre-service and in-service counselor training programs.

The case vignettes used in this project will be packaged in the form of a training program on eligibility determination. This package could be used by rehabilitation counselor training programs for pre-service training and by state Vocational Rehabilitation agencies for in-service training.

275 Development of Programmatic Research Issues Within Vocational Assessment

Principal Investigator:	Charles C. Coker, Ph.D.	
Status:	Continuing	
Dates:	June 1977-February 1982	
Cost:	Annual \$55,981 RT Annual \$45,823	Projected Total Not Applicable RT % of Annual Total 82%
Annual Report Reference:	#7, Page 73, R-30	

OBJECTIVES: The goal of this project is to develop, implement, and monitor a line of programmatic research and research utilization activities in the area of client selection and rehabilitation planning, with a particular focus upon those severely disabled persons who are referred to rehabilitation facilities for assessment and evaluation of rehabilitation potential.

This goal will be attained through the following specific objectives:

1. To identify researchable issues in the area of client selection and rehabilitation services planning, using the Center Advisory Committee, RSA R&E strategy, state rehabilitation agency personnel, rehabilitation facility personnel, and other input sources.
2. To develop a programmatic research strategy and research utilization plan based upon identified researchable issues, knowledge gaps, and priority concerns.
3. To prepare issue analysis and position papers based on literature reviews which identify specific knowledge gaps and which formulate researchable problems.
4. To conduct pilot studies which demonstrate research feasibility and/or resolve methodological and instrumentation issues related to identified knowledge gaps and researchable problems.
5. To make available for dissemination, research findings not included in other projects.
6. To develop research project proposals for submission to the Center's Advisory Committee, RSA Regional Office, and RSA Special Centers Office for review and approval.
7. To review the findings of Center programmatic research activities with the Center training section to insure that optimal dissemination and utilization of all findings is occurring.
8. To monitor and evaluate Center programmatic research and research from other sources related to client selection, rehabilitation planning, and the use of vocational evaluation procedures in client assessment and planning with the purpose of periodically revising the programmatic research strategy, research priorities, research activities, and research dissemination and utilization procedures.

METHODOLOGY: The methodology consists of four major activities:

1. **Programmatic Research Strategy:** The purpose of this step is to allow for the identification of a continuing research strategy which (1) identifies issues of priority concern; (2) defines the interrelationships between the issues; and (3) presents an orderly, systematic, and integrated programmatic research strategy for resolving the issues.

The programmatic research strategy is circulated for review, revision, and approval. It will be the basic programmatic research guide and will be periodically revised and updated to take into account new knowledge, changes in priority groups, etc.

2. **Issue Analyses:** Issue analyses will be concerned with: (1) the analysis and synthesis of existing knowledge related to the issue based upon literature reviews, (2) the identification of knowledge gaps which prevent resolution of the issues, (3) the formulation of specific researchable problems or questions which need to be answered to remove the knowledge gaps, and (4) identification of priorities and allocation of responsibility for dealing with the researchable problems and questions. The preparation, development, and publication of specific issue analysis will follow the sequence of issues identified in the programmatic research strategy.
3. **Pilot Studies:** The purpose of the pilot study is to determine whether it is feasible to conduct a research project related to an identified problem. These projects will be brief in nature and use a limited number of subjects. The basic intent is to determine such things as whether a design can be implemented, an instrument can be used, a coding system is reliable, etc.
4. **Project Proposals:** Project proposals will be submitted in the Annual Progress report or at other times during the year as appropriate. One management objective of the core developmental project concept is to insure that the development and submission of project proposals is a continuous process, rather than one in which ideas are "saved" for the Annual Progress report. The activities and products described above should insure the specific project proposals within this core area and will meet the following criteria: (1) specific relationship to programmatic research strategy, (2) adequate review of relevant literature, (3) clear definition of specific knowledge gap or problem, (4) adequate methodology for resolving knowledge gap/problem with pilot tests when necessary, (5) adequate utilization plan for findings by both rehabilitation in general and the Center.

FINDINGS TO DATE: Activities have been undertaken to define the areas of programmatic research, analyze issues, conduct pilot studies, and develop proposals.

Programmatic research. The Center's research activities can be classified on the basis of impact on the following categories of processes associated with handicapped individuals involved in the state-federal vocational rehabilitation system: (1) Service Delivery; (2) Role and Function of Rehabilitation Professionals; (3) Diagnostic and Assessment; and (4) Restoration and Training.

Issue Analysis. In the first year of the project, the issue analyses were confined largely to Vocational Evaluation. This year the issues related to the areas of programmatic research cited in the previous section which represents broad areas of functioning, but which are inter-related to one another.

In service delivery, the major issue centers around the measurement problem: How can we measure clients' functional capacities so that the impact of rehabilitation programs can be assessed?

Two other issues are being addressed in other projects. Counselors as gate-keeping decision-makers are being studied in a completing project (R-26).

In a second study (R-40), the issue of the impact of facility services on rehabilitation outcome is being investigated through tracking individual clients from intake to placement.

In the training of facility rehabilitation personnel, several recurrent issues have developed. These issues are being addressed in a completed project (R-25) and a proposed project (R-43).

The Center has begun a programmatic line of research in Adjustment programs centered around the examination of behavior change technology and Adjustment Specialist's competencies. The research now being conducted and proposed would provide a valuable data-base for developing and prioritizing the Center efforts in Adjustment Services.

Pilot Studies. Seven research pilot studies have been supported in one way or another by the Center. Two of these seven studies are completed doctoral dissertations at Michigan State University, two are doctoral dissertations now being conducted, another study is a proposed doctoral dissertation, and the remaining two studies are master's level research at the University of Wisconsin-Stout.

Project Proposals. The generation of research proposals is a complicated and lengthy process, but one which yields relevant projects of highest quality. The Advisory Council reviewed the four proposals and recommended submission in the current grant year. After RSA review, the projects will be reviewed by the University Committee on the Protection of Human Subjects Rights prior to the implementation.

APPLICABILITY: The products of this project can be generally used in rehabilitation in the following ways: (1) to identify significant issues and knowledge gaps related to the role and function of the facility-based vocational assessment and evaluation programs in client selection and rehabilitation planning; (2) to identify research priorities and to allocate resources to research on an orderly, systematic basis; (3) to resolve specific problems related to the design and instrumentation of research; and (4) to apply and implement new approaches and procedures which will enhance the use of facility-based services in client selection and planning.

As has been indicated above, the project is a developmental project which will serve to organize and integrate a series of programmatic research activities on vocational assessment and evaluation in client selection and planning. The Center will be a primary user of the products of this project in: (1) selecting research priorities; (2) allocating research resources; and (3) applying research findings.

276 The Effects of Vocational Evaluation on the Rehabilitation Client and Counselor

Principal Investigators:	Charles C. Coker, Ph.D. Geraldine Hansen, Ed.D.
Status:	Continuing
Dates:	July 1978-November 1979
Cost:	Annual \$28,908 RT Annual \$21,094
	Projected Total \$44,600 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 123, R-38

OBJECTIVES: The goal of this project is to determine the effects of Vocational Evaluation on the client and counselor. This goal will be attained through the following objectives.

1. Analyzation of data from pilot research examining the effects of Vocational Evaluation with respect to client change and functional disability.
2. Analyzation of data from pilot research examining the effects of Vocational Evaluation with respect to counselor information gain.
3. Interpret research findings and propose further research in this area.

METHODOLOGY: In the two studies, data from rehabilitation clients and counselors in Michigan have been collected. In one, approximately 46 rehabilitation clients referred to or awaiting Vocational Evaluation have been studied to determine the effects of Vocational Evaluation on their self-concept, vocational needs, and vocational information. In the second study, thirty vocational rehabilitation counselors have been assessed as to the degree of information they gained about a client as a result of their client receiving vocational evaluation services.

Study I: Client Change. The assessment of client change as a result of Vocational Evaluation consists of three areas: (1) general self-concept; (2) identification of vocational needs; (3) information gained. The following instruments were used: (1) The Tennessee Self-Concept Scale was used to assess individuals' perceptions of themselves; (2) The Attitude Scale of the Career Maturity Inventory was used to measure clients' vocational needs; and (3) A survey instrument was

developed which consisted of client information in three categories: (a) information about general worker traits; (b) information about specific work skills, aptitudes, interests; and (c) information about specific work environments.

Twelve rehabilitation facilities in Michigan were selected. The three instruments measuring client change were administered to each client entering the facility for evaluation services during a four week period. As each client completed evaluation, the tests were readministered to him/her. Clients awaiting vocational evaluation services in the participatory facilities were also tested on pre post-test basis over a time interval equal to the length of time of evaluation services. A total of 46 clients were tested, 34 clients who had completed evaluation and 12 clients who had not participated in evaluation.

Study II: Counselor Information Gain. An instrument (Client Assessment Survey) was designed to measure counselor knowledge concerning their clients' vocational abilities and skills. In addition, a 6 point Likert Scale was used to further measure the counselors' degree of certainty concerning the accuracy of each response. Each counselor was administered the Client Assessment Survey (CAS) prior to their clients' commencement of evaluation services. After each client completed evaluation, the CAS was readministered to the counselor. Another CAS was completed by the participating counselors on a pre post-test basis for a client referred to but awaiting evaluation services. Counselor and client demographic information was collected for analysis.

FINDINGS TO DATE: This year's activities have examined the utility of Vocational Evaluation Services for the referring counselor and client. The findings which are reported below are based upon a preliminary analysis of the data collected respective to the two prime objectives of the project. The final analyses of the data from the studies will be completed by the end of the grant year.

Counselor Information Gain (Study II): Assessment of the amount of information counselors gain of client information and the extent to which their certainty of the information increased as a result of Vocational Evaluation Services was explored. Thirty-five counselors from Michigan Bureau of Rehabilitation were pre- and post-tested as to the amount of information they possessed concerning a client's vocational assets and liabilities whom they had referred to vocational evaluation using a Client Assessment Survey.

The instrument was used to test two hypotheses: (1) Counselors will gain significantly greater amounts of information with respect to clients who complete work evaluation than for a matched group of clients who do not complete evaluation, and (2) Counselors will gain a significantly greater amount of certainty with regards to information possessed for those clients who complete work evaluation than for those clients who do not complete work evaluation.

Weinstein (1978) concluded that counselors gained both a significant amount of information as well as an increase in the certainty of that information following a client's involvement in vocational evaluation services. The results further indicated that evaluation provides counselors with the ability to effectively define their client's vocational assets and liabilities with regard to job goals, General Educational Development, Aptitudes, Temperaments, Work Attitudes, Attributes and Interests, Job Retention Skills, and Stability Characteristics. The results, however, did not indicate that evaluation provides the counselor with any additional information concerning the client's Physical Capacities and Job Seeking Skills.

While additional information concerning Physical Capacities and Job Seeking Skills did not seem to be an outcome of a client's involvement in vocational evaluation, counselors did seem more certain of this type of the Physical Capacities and Job Seeking Skills information they already possessed. Increases in certainty also occurred for information counselors possessed on the other six scales. This suggests that vocational evaluation services may serve the dual function of both providing the counselor with new information and confirming or disconfirming information the counselor already possesses.

Client Change (Study I): Two studies examined the effects of Vocational Evaluation on clients. Chandler (1978) conducted a study of client change as measured on several dimensions. Change in self-concept was measured using the Tennessee Self-Concept Scale. The Career Maturity Inventory-Attitude Scale was used to measure change in vocational maturity. Ability to state a job goal was assessed in an interview with the client. In addition to these dimensions, a survey was developed to explore the possibility that clients gain information about their voca-

tionally related assets and liabilities as a result of vocational evaluation. As reported by Chandler, (1978), there were no significant differences between clients participating in vocational evaluation and clients not participating in vocational evaluation as measured on the three instruments.

Post hoc analysis of Chandler's data was restricted, due to the few number of subjects across facilities, prohibiting a regression analysis from being computed to determine variables significant in predicting change. It was anticipated by Chandler that the twelve vocational evaluation programs would differ in the level of client participation and that possible interaction of this effect on client change would exist. Again, the small sample of subjects (34) across twelve facilities did not permit a post hoc analysis of this data.

The methodological problems encountered by Chandler were considered and controlled for in a study initiated by Hein (1979). Hein investigated 32 clients participating in vocational evaluation at the Vocational Development Center, identified as a high level client participatory program. Hein used the same measuring instruments as Chandler in a pre-test, post-test design. A preliminary analysis of the data with respect to the Career Maturity Inventory (CMI) Attitude Scale and Tennessee Self-Concept Scale indicated that statistical significant changes did occur. Participants in the study were involved in vocational evaluation, but either entered a two week evaluation program or a three week program consisting of two weeks of evaluation similar to the other group, and one week of values clarification. All clients (two week and three week client groups) had significant changes in their post-test scores on the CMI-Attitudinal Scale when compared to their pre-test scores.

A t-test was computed on the mean change scores from the pre-test and post-test scores between the two and three week groups. The results indicated the mean change for the two groups of clients did not differ significantly from each other. With respect to the same clients and programs, the analysis of data obtained from the Tennessee Self-Concept Scale (TSCS) indicated some differences occurring from the pre-testing of clients to the post-testing.

For all clients, the following six sub-scales were significant: (1) Total Positive, (2) Self-Satisfaction, (3) Behavior, (4) Physical Self, (5) Personal Self, and (6) Social Self. The clients in the two week program changed significantly on the following scales: (1) Self Satisfaction, (2) Behavior, (3) Physical Self, (4) Personal Self, and (5) Social Self; whereas, the clients in the three week program only changes on one scale, Social Self.

Further analysis of the TSCS data obtained on the clients in the two and three week program was computed. The mean change scores for all scales, between the pre-test and post-test for the two and three week program participants were compared. The results indicate only one scale (Self Satisfaction) where the difference in the pre-test and post-test scores for the two week group was significantly different compared to the change of pre-test and post-test scores for the three week group. On examining the Self Satisfaction dimension, two week clients changes significantly ($t(17)=-4.33$; $p<.001$), whereas three week clients did not change ($t(13)=-.146$; $p<.05$).

Preliminary analyses indicates that there are significant differences occurring for persons during their vocational evaluation program as measured by the CMI-Attitude Scale and TSCS on pre- and post-administrations. Hein also suggests that the differences occurring between the two and three week groups in favor of the two week group could possibly be with respect to the demographic variables, age, and referral source. A significant difference between the groups exists with respect to age; the two week group being older.

Since Hein (1979) and Chandler (1978) differ in their initial analyses of data and design, further analyses are expected to be continued prior to any final report.

APPLICABILITY: The purposes of these studies were to indicate the effects of Vocational Evaluation on: (1) counselor gain of client information; and (2) client change in vocational maturity, vocational needs, and self concept. Since vocational services are becoming more and more scrutinized by various interest groups, legislative groups, and service purchasers; the findings of these studies are applicable to the issue of measurement of expected outcomes of services.

Preliminary findings from this study indicate that the measurement assessing Vocational Evaluation effects on counselor gain of client information is sensitive and a valid estimate. State

and facility personnel can use this approach to determine effectiveness for professionals. The initial analyses of Chandler (1978) and Hein (1979) data indicates different outcomes. Whereas, Chandler did not find significant change for clients, Hein did. The difference occurring in the studies' design needs to be further investigated. Presently, the instruments measuring the effects on clients are sensitive with given client population. Should more detailed analysis of these data indicate that this approach is sufficiently sensitive, a needed method will be available to state and facility personnel.

277 An Exploratory Study of the Vocational Decision-Making Skills of Clients

Principal Investigator:	Thomas Czerlinch, Ph.D.	
Status:	New	
Dates:	July 1978-December 1979	
Cost:	Annual \$34,688 RT Annual \$25,311	Projected Total \$102,400 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 105, R-37	

OBJECTIVES: To conduct an exploratory study on the extent to which Vocational Evaluation clients experience vocational decision-making problems and compare the type of problems these clients experience to those experienced by clients at a different stage in the rehabilitation process as well as those experienced by a selected segment of the general population.

METHODOLOGY: To assess the vocational decision-making problems experienced by this group, a vocational Decision-Making Interview (DMI) was developed and administered. The DMI was constructed on the basis of the relevant research literature and the experiences of a number of rehabilitation professionals. Extensive content validation and item analysis procedures were utilized, and the final form of the DMI was an interview format made up of three scales—Employment Readiness Scale, Self-Appraisal Scale, and Decision-Making Readiness Scale. Reliability estimates for these three scales were .62, .63, and .79 respectively, and the reliability to the total DMI scale was .84. Inter-scale correlations ranged from .38 to .55, and the correlations of the scales with the total DMI score ranged from .70 to .88.

Two additional instruments were administered concurrently. A demographic questionnaire was used to gather information about the characteristics of the sample and the Career Maturity Inventory -Attitude Scale (CMI) was used as an indicator of the concurrent validity of the DMI.

Three groups of 30 subjects each were used. The first group, vocational rehabilitation clients in vocational evaluation, was chosen to represent vocationally undecided clients. The second group was comprised of vocational rehabilitation clients in vocational training, selected to be representative of vocationally decided clients. The third group were seniors in high school, who should represent a mixture of vocationally decided and undecided individuals.

Each subject was administered the DMI and the demographic survey orally in an individual interview. The CMI was administered orally in a group at the end of the day.

FINDINGS TO DATE: **Concurrent Validity:** Correlational analyses were conducted to examine the degree of relationship between the DMI total (and the scales) and several independent indicators of decision-making. These indicators were (1) the CMI, Attitude Scale, a theoretical indicant of vocational maturity, (2) an item asking the subject to state three job goals, and (3) an item asking the subject to state three career goals. Result showed that the DMI obtained significant positive correlations with all three indicators. The Decision-Making Readiness scale was found to have a significant positive correlation with the item asking about job goals, and marginally significant correlations with the other two indicators. This overall pattern of correlations indicated a reasonable degree of concurrent validity for the DMI.

Discriminant Validity: Analyses of variance were conducted on both the total DMI scores and the three scales to see whether differences existed among the three groups, who were chosen to represent individuals who differ in the degree to which they have made (or are able to make) vocational decisions. The major results were that the mean differences of the three groups on the

DMI total score obtained marginal significance ($p < .07$) with the Training group > High School group > Evaluation group. The mean differences on the Decision-Making Readiness scale also obtained marginal significance ($p < .09$) again with the Training group > High School group > Evaluation group. The mean differences on the Employment Readiness scale and the Self-Appraisal scale were clearly not significant ($p < .14$ and $p < .19$, respectively). Thus, the analysis of the means suggested that, on the DMI total score and the Decision-Making Readiness scale, there was a tendency for those clients in vocational training to obtain a higher score than those clients in vocational evaluation, with the high school students falling at an intermediate point.

Neither of these findings, however, reached the typically accepted level of probability ($p < .05$) required to reject the hypothesis of no difference, so the above findings suggest a **trend** in the total score and the subscales, but do not statistically support this hypothesis.

To test whether there were significant differences in the variances (heterogeneity), Bartlett's tests of homogeneity were calculated on the data from the three groups of subjects, again using the DMI total and the subscales. The results showed that, on Employment Readiness, the Evaluation group > High School group > Training group ($p < .05$); on Decision-Making Readiness, the High School group > Evaluation group > Training group ($p < .01$); and on the total score, the Evaluation group > High School group > Training group ($p < .05$). No significant heterogeneity of variances was found on the Self Appraisal scale. These results appear to indicate that while the high school group was not consistent in terms of their variability, the Evaluation group of clients were more heterogeneous in their scores on the total DMI scale as well as on two of the three subscales.

Further research on the DMI is currently being conducted and is clearly called for in order to be able to make additional statements regarding the predictive validity of the instrument.

It is the aim of the continuing line of research to: (1) attempt a refinement of the DMI; (2) test the predictive validity of the DMI by doing a follow-up of as many of the clients in the original sample as possible; and (3) gather some information about whether parts of the DMI remain stable over time, whether they covary with the actual job success experienced by the individual, or whether they are unstable (unreliable) as measured at a later point in time (unrelated to actual vocational experiences).

APPLICABILITY: This study examined the basic functional capacity of vocational rehabilitation clients to make decisions regarding their own vocational future. It was pointed out that the outcome of vocational evaluation services may depend on the client's ability to make such decisions. In this regard, it may be crucial to be able to assess a client's ability to make vocational decisions so that evaluators can maximize the benefits that clients are able to receive from the process of vocational rehabilitation.

278 The Functional Capacities Inventory in Service Delivery

Principal Investigator:	Fredrick E. Menz, Ph.D.	
Status:	New	
Dates:	July 1978-May 1981	
Cost:	Annual \$11,563 RT Annual \$8,437	Projected Total \$87,695 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 31, R-39	

OBJECTIVES: The Functional Capacities Inventory (FCI) was conceived as a tool which vocational rehabilitation counselors, evaluators, and adjustment specialists can commonly use in communicating and in planning and delivering vocational evaluation and work adjustment services. As the goal of this project is to develop a tool which will enhance appropriate utilization of diagnostic and adjustment services, the objectives are geared toward determining whether the FCI is sufficiently reliable and valid to be used in effective communications with individual clients or groups of clients. These objectives, therefore, are as follows:

1. To determine the content validity of the FCI for use in Vocational Evaluation and in the planning and delivery of Work Adjustment Services.

2. To determine the reliability of the FCI for use in Vocational Evaluation, in development of IWRP's, and in Work Adjustment Programming.
3. To determine the utility of the FCI for planning and communicating between counselors, evaluators, and work adjustment specialists.
4. To develop the necessary instructional or training materials for effective use of the FCI in service delivery by counselors and service personnel.

METHODOLOGY: Subjects: The primary subjects in the study are vocational rehabilitation counselors, evaluators, and work adjustment specialists representative of a diversity of clients, caseloads, and agency and facility settings. It is estimated that approximately 90 professionals will complete FCI's on approximately 465 clients representative of the dominant disability groups generally referred for evaluation and adjustment services.

Instruments: Respective to their roles, counselors, evaluators, and adjustment specialists will provide three types of responses to the statements contained in the FCI: a summative judgment of capability; a focused analysis of capability; and a decision regarding service needs. Demographic and survey data on the professionals and the clients on whom FCI's are completed will also be gathered for descriptive purposes and to evaluate the utility of the FCI for professionals.

Procedures: Content Validity. A sample of approximately fifteen academic and practicing evaluators, adjustment specialists, and rehabilitation counselors will review the content and the instructions for the FCI to determine whether the statements are sufficiently inclusive, are clearly stated, and are commonly understood and to insure that assignments of statements to scales are appropriate.

Reliability. Estimates of the stability of responses and the equivalence with which the professionals respond to the FCI on clients will be sought in the two reliability studies. The first reliability study will focus on estimating test-retest and inter-judge reliability within each of the three groups of professionals (counselors, evaluators, and work adjustment specialists). The second reliability study will focus on estimating inter-judge reliability among the professional groups, i.e., the FCI's reliability in the context in which it is expected to be used.

Fifteen counselors, fifteen evaluators, and fifteen adjustment specialists will complete FCI's on three clients from their current caseload and adjustment specialists will independently complete the FCI on each of the three clients. Approximately one week later, the original fifteen counselors, fifteen evaluators and fifteen adjustment specialists will complete a second FCI on each of the clients. FCI's will be available from evaluators on ninety clients, from adjustment specialists on ninety clients, and from counselors on 135 clients. A criterion level $p < .01$ was set for the average rates of agreement or correlations across clients, to judge the FCI as a reliable tool for use with clients. The incomplete block design underlying the study will also allow secondary analyses to isolate sources of variability attributable to client, professional, and items in the FCI.

The second study will track clients from initial referral through adjustment to obtain estimates of the equivalence with which the professionals judge clients. Each of thirty counselors will complete FCI's on five clients as clients proceed through rehabilitation. Evaluators and adjustment specialists will also complete FCI's as each of the clients enter and complete their respective services, yielding a total of seven FCI's on each of 150 clients. Inter-judge (equivalency) reliability estimates (rates of agreement and correlation) will be computed among counselors, evaluators, and adjustment specialists at referral to evaluation, completion of evaluation/referral to adjustment, and completion of adjustment. If the FCI is a reliable tool for use in communicating client capacities, level of functioning, and priority needs, the average rates of agreement or correlations across clients are expected to exceed the .05 level of significance.

Utility. Counselors, evaluators, and adjustment specialists who participate in the reliability studies will be queried approximately three months after FCI data have been gathered via a survey or structured interview to solicit their perceptions of the FCI as a planning and communications tool. This survey/interview will be such that the FCI's utility can be estimated and to develop instructional or training materials needed for effective use of the FCI. Attention will be given to determining the degree to which the FCI is used beyond the experiment by participants and their colleagues, whether communications are enhanced; whether more specific referrals result; and whether services are more specifically designed to meet individual client needs.

FINDINGS TO DATE: Efforts to date have been directed at insuring content validity in the FCI examination and revision of the content and pool of statements for the FCI and revision of the FCI's structured response format were undertaken to increase the likelihood that the FCI will be an effective tool for summarizing vocationally relevant capacities of a client at critical points in his/her summarizing rehabilitation.

Revision and expansion of the content focused on the original pool of fifty-two statements and the five original vocationally relevant domains of capability: Personal-Social Capacities; Vocational Maturity and Planning Capacities; Job Seeking Capacities; Job Holding and Advancement Capacities; and Stability Capacities. Presently, 115 revised, restated and new statements have been written and the five capacity domains collapsed under three capacity themes: Personal Capacities; Vocational Capacities; and Independent Living Capacities. Revision of the structured response format was initiated so that counselors and service providers provide three types of analytic responses about a client to each statement: (1) Client's Capability is a broad screening of the client's capability and whether the counselor or service provider has sufficient knowledge of the client to judge capability, (2) Refined Analysis of Capability is a more diagnostic screening in which the respondent's uncertainty about the client's functioning is brought together with his/her estimates of both how well and how appropriately the client can do what is implied in each capability statement, (3) Priority is a decision-making response as to whether and what types of services are called for based upon the counselor's or service provider's summarization of the client's functioning. The response format allows the counselor or the service provider to quickly summarize his knowledge of the client and focus in on only those capacities for which his/her knowledge is incomplete or for which the client's functioning is in some way limited.

APPLICABILITY: If the FCI is found valid and useful for the purposes it is intended, then it should provide a much needed and effective tool for referral-planning and delivery of services to clients. Counselors might use it for identifying informational needs in eligibility determination, for establishing priorities among their referral questions, and in monitoring client progress toward employability as the client proceeds through the services. The evaluation and adjustment specialists should be more responsive to the expectations and priorities of the counselor's referral, more economically establish priorities in their service, directly plan and monitor delivery of the service, and more concisely and accurately communicate answers to referral questions.

The primary impact of this study, therefore, is expected to be on how rehabilitation is delivered to clients by counselors and service providers. As counselors, evaluators, and adjustment specialists are better equipped with systematic methods for planning referrals to services and for planning and delivery of those services, four contingent impacts may be expected: (1) the reasons for referral may be more concise/prescriptive and better articulated to service providers; (2) more clearly articulated referrals may result in shorter and lower cost diagnostic and treatment programs; (3) better sequencing of services and specifically directed services may make more opportunities for rehabilitation services available to greater numbers of disabled persons; and (4) time and opportunity to devise innovative delivery methods particular to specific classifications of client functional capability might make a broader range of effective programming possibilities available than is currently provided through today's service programs.

279 Facility Services—A Tracking System

Principal Investigator:	Fredrick E. Menz, Ph.D.	
Status:	New	
Dates:	July 1979-July 1982	
Cost:	Annual \$31,799 RT Annual \$23,204	Projected Total \$113,488 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 51, R-40	

OBJECTIVES:

1. To obtain a usable and accurate picture of how rehabilitation facility services in Wisconsin are delivered to clients.

2. To obtain a usable and accurate picture of how the rehabilitation system in Wisconsin is delivered to clients who receive vocational evaluation and work adjustment services as part of their rehabilitation program.
3. To develop a client tracking and data retrieval system which will allow the state of Wisconsin to update this picture in advance of the regular planning and redevelopment cycles.

METHODOLOGY: Subjects: The principal subjects in this study are state agency vocational rehabilitation clients. However, a consortium of vocational rehabilitation practitioners has also been drawn together to provide input at critical points in the project's development and dissemination. Wisconsin vocational rehabilitation clients receiving facility services between October 1, 1977 and September 30, 1978, will be included in a pilot study to determine the utility of Wisconsin's Facility Form (DVR-85) for tracking clients through facility services to closure. Clients entering the program on or after April 1, 1978 and before October 1, 1981, will be subjects of the longitudinal study of how services are delivered to clients.

Instruments: The initial instrument of concern will be Wisconsin's Facility Form (DVR-85). These are merged with the state's client service (DVR-2), fiscal (DVR-40) and follow-up data (DVR-52) to comprise data for both cross-sectional and longitudinal studies of clients in the rehabilitation program and receiving facility services.

Procedures: The four steps in this study involve identification of questions of concern to be asked of a client data tracking system, and implementation of a formal longitudinal study of clients with the client data tracking system.

- Step 1. The practitioner consortium consists of representation of the state rehabilitation agency, rehabilitation facilities in Wisconsin and the RTC staff. It functions primarily (1) to pose questions of concern about the provision of facility services to the vocational rehabilitation client that could be addressed with a client data tracking system prior to the data analysis in the pilot study, and (2) to adequately answer their questions should analysis of the pilot data provide inadequate or only partial answers. The consortium has been selected and has identified a "laundry list" of concerns about clients and the effects of services on clients, both from the state agency and facility points of view. These concerns will form the basis to determine whether DVR-85 (in conjunction with client service, fiscal, and follow-up data) provide partial or full answers to the concerns phrased as research questions. Issues or concerns raised by the consortium fell into two topical areas: (1) Who is the client in the vocational rehabilitation system? (e.g., who is the vocational evaluation client?), and (2) How are facility services being provided (e.g., what is the probability of a client who receives vocational training becoming employed?).

Step 2. Analysis of DVR-85 data will provide both descriptive cross-sectional and longitudinal characterizations of clients going through rehabilitation. Cross-sectional analyses will be in terms of frequencies, percentages, and means and standard deviations relating DVR-85 data to significant client service, fiscal and follow-up variables also contained in the existing data system and pertinent to the concerns raised by the consortium. Descriptive longitudinal analyses will employ the Automatic Interaction Detection (AID) Program. AID is a multivariate analysis technique which is useful with categorical data, such as that on the DVR-85, has the major advantage of being useful in predicting outcomes at several points in the rehabilitation process, and has an additional advantage in that AID forms clusters of individuals having similar probabilities for a particular kind of outcome. Thus, analysis of data are focused on the interaction of client variables and the patterns of services for clients.

Step 3. Refinement of the client data tracking system will follow analysis of DVR-85 data and involves use of the consortium to determine the extent to which their concerns have been met through those analyses of existing data. Concerns and questions posed, but unanswerable, will provide the basis upon which refinement of the system is expected to take place. Three directions which might be expected could be (1) revision of DVR-85 to incorporate new data items, (2) development of a new system to collect needed data items, or (3) integration of DVR-85 with other existing but untapped formal sources of information in facilities or the state agency.

Step 4. Implementation of a longitudinal study of the rehabilitation client and delivery of facility services to clients will formally commence after refinement of the client data tracking system. This phase of the project is expected to be a demonstration of the applicability of a research data base for answering specific administrative questions and for estimating existing or predicted

effects of service delivery on clients which are needed for planning, development and operation of an effective and dynamic state vocational rehabilitation program. A 10% random sample of all clients entering the state rehabilitation program on or after 1978 and up to October 1981 are being selected as the subjects of this research and demonstration phase of the project.

FINDINGS TO DATE: The five primary activities accomplished or undertaken to date are activities critical to accomplishing this research. First, issues and concerns have been collected from the project's consortium and phrased into research questions related to client, professional and program variables. A second major accomplishment has been in obtaining complete tape copies of all data in the state's administrative computing systems (IBM) and translation of that data for use with a Univac computer. The third accomplishment appears to be development of an effective method for creating and maintaining a "querriable" master data base using the Unified Data Handler and Miser Data Base system at the Madison area computing center. If it is as effective as expected, this accomplishment will be unique in that this master data base is capable of merging original client service data (DVR-2) fiscal data (DVR-40) follow-up data (DVR-52) and DVR-85 data from four different sources; regularly updating with new information on existing clients; updating with new data on new clients entered; and is susceptible to analysis with such standard statistical packages as SPSS and BMD.

The fourth accomplishment has been to establish a continuing relationship with the state agency to receive new and updated copies of 10% random samples of all clients entering and continuing through the system between April 1, 1978 and October 1, 1981 for the longitudinal study. The last activity under the project has been to formally initiate cross-sectional analyses of all data gathered for the pilot study.

APPLICABILITY: This project is expected to provide state agency and facility administrators with longitudinal data for planning in relation to clients served. It is further anticipated that the data will provide the field with an understanding of the vocational rehabilitation client and his service patterns and outcomes. With respect to rehabilitation personnel, the findings should identify staff needs for training and agency needs for staffing.

While this project will provide longitudinal information about the vocational rehabilitation client for the state agency and rehabilitation facilities in Wisconsin, it is possible that the project findings will be relevant to other states as well when they plan for clients and especially clients who will receive services in facilities. In particular, though, the method for creating and using a client data tracking system in planning and program development might be expected to have high utility for state programs.

280 The Point Sampling Approach to Assessing and Monitoring Behavior in Adjustment Services

Principal Investigator:	Gerald Schneck, M.S.	
Status:	New	
Dates:	July 1978-December 1980	
Cost:	Annual \$37,581 RT Annual \$27,423	Projected Total \$95,450 RT % of Annual Total 73%
Annual Report Reference:	#7, Page 143, R-41	

OBJECTIVES: The purposes of this project are to develop a systematic behavioral observation system which is technically reliable and valid; refine the system to enhance its implementation in various rehabilitation program settings; and develop a curriculum package for training practitioners on the basic, but essential skills of observing and recording vocational behaviors in adjustment programs.

The methodology has two main aspects: (1) a Monte Carlo computer simulation of continuous behaviors that occur in a workshop has been developed along with a computer program to sample that behavior as desired and (2) the implementation of the Point Sampling system by staff of three rehabilitation centers. The methodology, therefore, will enable Center staff to refine

the system so that it is practical for use in rehabilitation programs without losing the technical accuracy of a systematic observation schedule.

Cooperative research relationships with three rehabilitation facilities in the Twin Cities area (Minneapolis-St. Paul) have been developed for the implementation of the Point Sampling approach in practical surroundings. Each of these facilities has been selected because of their diversities in: philosophy; approach; environmental surroundings; program availability; clientele served; staff backgrounds; etc. Initial training in the present Point Sampling approach will be provided to their staff. Each facility will then implement this approach for a brief period with continuing follow-up of Center staff. Modifications to the procedures and testing will follow, as becomes necessary, due to program objectives, needs and specific conditions evidenced.

Alternative manners of implementation will be fully described within a final report and training package.

FINDINGS TO DATE: The Point Sampling approach to behavior observation is based upon the gathering of frequency data on specific behaviors which are included in a behavioral hierarchy. This hierarchy can have several branches which represent behaviors expected in a work environment. Theoretically, the behavior observed can be coded into one and only one branch of this hierarchy, at any single point in time. The primary branches of this hierarchy include on-task and off-task behavior. Further branching, within each of these categories, allows for more specific behavioral information to be collected (e.g., On-task Behavior: Attending, Looking Around, Talking, and Other). The hierarchy is used as a method of organizing behavior for recording, analysis and interpretation. To implement the hierarchy approach into actual behavior observations, the practitioner establishes a periodic and systematic schedule for making individual observations. Each time an observation occurs, the practitioner looks at the client, codes the behavior observed, and records it on a data sheet. Additional information is collected with this approach, that relates to production quality and quantity, for later use in assessment of behavior on production output and prediction of performance levels after treatment.

The Point Sampling approach has also been employed in a Vocational Adjustment setting to assess and monitor the behavior of individual clients. A formula was developed to estimate the potential production rate (PPR) of a client, given the elimination of off-task behaviors. The formula is as follows:

$$\text{Potential Production Rate \%} = 100 \times \frac{\text{Current Production Rate \%}}{\text{Current on-task \%}}$$

Such a formula could be utilized to give an estimate of the increase in production rate on an actual work task or work sample based on the theoretical assumption that every decrease in off-task behaviors would result in an equal increase in the production ability of the client. This application of the Point Sampling system has not been researched.

A two-level behavioral hierarchy code has been used with some success. Behavior is coded for on-task or off-task and then for four different types of behavior under on- or off-task. Two different intervals of Point Sampling have been used. In one approach, client behavior was observed every 5 minutes during the day over a two week period. In a second, client behavior was observed for periods of ten minutes throughout the day. Observations were recorded every 10 seconds during the 10 minute period. Both approaches are useful. In the first, more behavior of the client is observed over many different tasks. In the second, more specific behaviors in relation to one task are recorded.

This present research study has several purposes that extend these initial investigations, which include: (1) refinement of the technical aspects of the Point Sampling approach, to increase confidence and reduce error of measurement in the results of its implementation; (2) systematic examination of the validity and reliability of the observation system and its subcomponents; (3) determination of work performance; and (4) development of training materials on the use of Point Sampling in adjustment programs.

APPLICABILITY: The development of a behavioral observation system such as this not only provides a significant technique for conceptualizing client problems, but is also an excellent basis for building staff competencies in behavior identification and analysis.

University of Wisconsin-Stout

This project attempts to improve the method by which individual client behavior can be observed and recorded. It is aimed at development of a behavioral observation system that is technically accurate in the way in which it is structured, practical in the ways in which it can be implemented, and easily learned by practitioners in order for them to become skilled in behavior observation and interpretation of behavior.



**University of California/San Francisco (RT-23)
Research and Training Center in Deafness and Mental Health**

CORE AREAS

Work Adjustment as a Function of Self-Image and Mental Health

Studies which will allow the Center to make predictions about the vocational adjustment of deaf people and to test the predictions with follow-up data on actual vocational performance. Results of this research will provide rehabilitation counselors and administrators with information that should lead to better understanding and more effective treatment of their clients.

Improving Clinical Training of Personnel Working with Deaf

Development of measures of the trainee counselors' knowledge of deafness, their knowledge of clinical principles and their behavioral effectiveness. These measures will be used to assess changes as a result of the training program.

Communication as It Affects the Vocational Rehabilitation Process for the Deaf

Investigating the contribution of the communicative competence of clients and counselors; as well as investigating the effect of introducing interpreters into the rehabilitation setting.

Evaluation of Therapeutic Intervention for the Deaf

Investigation into the use of skilled interpreters in the therapeutic process—crisis intervention, family therapy and psychosocial testing—which may open up pathways for professionals new to the field of deafness; and exploring the feasibility and optimal timing of developmental compensation.

Evaluation of the Mental Health Needs of the Multiple-Handicapped Deaf

Research to (1) provide for further evaluation of the needs of severely disabled deaf and (2) develop ways to best meet those needs through the available clinical services or through the creation of specialized services within the Center.

Special Problems of Members of Deaf Minority Groups

Research in similarities between the deaf and racial/ethnic minority groups and the personal and social consequences of the combined stigma. Anthropological research among the general deaf community, and cross-cultural investigations of the treatment and rehabilitation of deaf persons in the various subgroups would add a significant dimension to the Center's research program.

Development of Guidelines for Clinical Histories and Appropriate Clinical Forms

Studies aimed at determining background variables which are inappropriate for other groups but which are essential for an accurate assessment of deaf clients (e.g., degree, onset, and etiology of loss; and educational and audiological history). Such a description would be useful to other centers in planning services for deaf clients and in the development of clinically and vocationally oriented forms.

UNIVERSITY OF CALIFORNIA/SAN FRANCISCO

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COMPLETED

ABSTRACT NO.

- The Development of a Communication Skills Profile
(H.S. Schlesinger, M.D.) 281

CONTINUING

- A Longitudinal Study of Self-Image and Work Adjustment of
Young Deaf Adults (H.S. Schlesinger, M.D.) 282
- Improving the Effectiveness of Psychotherapy for the Deaf
(formerly: Crucial Variables in the Clinical Effectiveness
of Personnel Who Work with the Deaf)
(H.S. Schlesinger, M.D.) 283

PROPOSED

- Precursors to Vocational Adjustment: Adolescent Follow-Up Study

281 The Development of a Communication Skills Profile

Principal Investigator:	Hilde S. Schlesinger, M.D.	
Status:	Completed	
Dates:	January 1978-January 1979	
Cost:	Annual \$11,456 RT Annual \$11,456	Projected Total Not Applicable RT % of Annual Total 100%
Annual Report Reference:	#2, Page 113, R-3	

OBJECTIVES: The objective of this project is to develop a Communication Skills Profile for training the following: (a) Oral speech and speechreading; (b) Signed English (expressive and receptive); (c) Ameslan (expressive and receptive); (d) Fingerspelling (expressive and receptive); and (e) Print (writing and reading). These ratings can facilitate evaluation of the extent to which client and therapist can communicate with each other, assessment of the effects of psychological counseling upon the communicative proficiency of the client and assignment of clients to therapists also can be improved through such profiles.

METHODOLOGY: Communication Skills Profile and a manual of instructions for its use have been developed and refined for use in mental health settings as well as for broader rehabilitation purposes. The Communication Skills Profile was refined from the version included in the 1978 Annual Progress Report.

The revised Communication Skills Profile retains scales for rating both Expressive and Receptive skills in five modes of communication: (1) Oral, (2) Signed English, (3) Ameslan, (4) Fingerspelling, and (5) Print. Pilot work with the original version led to a number of modifications which serve to increase the clarity and meaningfulness of the rating points. In brief, changes have been made as follows:

1. We have redefined some of the rating points so that rating is more comparable at each point across modes—as reflecting a comparable quantitative level.
2. We have separated out the quality of skill from the quantity of skill for each Expressive mode.
3. We have provided categories for the rater to indicate the range of situations, and the Hearing Status and Communication Modes of those with whom the rater has observed the individual communicating.
4. We have included a way of coding the level of skill in both Sign English and SEE Signs.

To facilitate the usefulness of this Profile in Centers other than our own, we developed also a Manual of Instructions for Raters which specifically defines the meaning of each rating point and describes procedures for observing and rating individuals.

FINDINGS TO DATE: After revising the profile Form and preparing the Manual, two Research Associates were trained in the use of this instrument.

The Communication Skills Profile as now refined can be used in a variety of settings and for a variety of purposes related to the rehabilitation of deaf persons. First, the Profile can be used by counselors in schools to assess the communication skills of students whom they refer to mental health services. These Profiles can be sent to the mental health service for purposes of assigning therapists whose skills most closely match those of the student.

More generally, the Profile also can be used by the mental health agency itself to assess the level and quality of communication skills of a variety of hearing-impaired incoming patients in order to assign them to therapists with the most appropriate communication skills.

Second, the Profile can be used by vocational rehabilitation counselors to assess the skills of their clients. This assessment would be useful in matching clients' communicative skills with the requirements of job placements or in determining the need for additional communication training prior to job placement. Where vocational rehabilitation counselors found the need to refer a client to mental health services, the Profile again could be used by the mental health services for purposes of assigning therapist to patient.

And third, the Communication Skills Profile can also be used for research purposes. As noted above, we are using this Profile now in our research study of the vocational adjustment of young deaf adults, described in report on Project R-1.

APPLICABILITY: The Communication Skills Profile II, developed in research project R-3, is currently being utilized as a measure of communicative competence in our research study on the vocational adjustment of young deaf adults (Project R-1).

The Communication Skills Profile II can be used for a variety of purposes related to the rehabilitation of deaf persons. First, the Profile can be used to assess the level and quality of communication skills in order to assign patients to therapists who have the most appropriate communication skills. Second, the Profile can be used by vocational rehabilitation counselors to assess the communicative skills of their clients in order to match clients' communication skills with the requirements of job placement or in determining the need for additional communication training prior to job placement. And third, the Communication Skills Profile can also be used for research purposes.

282 A Longitudinal Study of Self-Image and Work Adjustment of Young Deaf Adults

Principal Investigator:	Hilde S. Schlesinger, M.D.	
Status:	Continuing	
Dates:	October 1977-September 1980	
Cost:	Annual \$51,293 RT Annual \$51,293	Projected Total \$168,700 RT % of Annual Total 100%
Annual Report Reference:	#2, Page 5, R-1	

OBJECTIVES: To describe the vocational success and general well-being of a group of young deaf adults who are still in relatively early career stages.

To relate earlier obtained measures of self-image, psychosocial adjustment, communication skills, academic achievement, family climate and history to vocational success.

To use relationships as a guide to the possible modification of earlier experiences so that the deaf student will have a better probability of achieving vocational success.

METHODOLOGY: In 1966-67, Meadow amassed a great deal of information on 116 students at the California School for the Deaf, Berkeley, California. The first step in studying this sample has been locating each individual and determining if he or she wishes to participate in this study. During this same time period, a literature search was conducted on the vocational characteristics of deaf adults. Based on the findings of this survey, an interview schedule has been developed to use with the cooperating subjects. Information on vocational success is being obtained and statistically related to the data collected twelve years earlier. In addition, a modification of the Tennessee Self-Concept Scale, if it proves reliable, will be used to measure self-concept and correlate this with vocational adjustment.

FINDINGS TO DATE: The sample being studied now ranges in age from 18 to 30 years. Only a very few of these were still at the California School for the Deaf, Berkeley. Letters describing the interest of the Center in contacting these students were circulated, providing the students the opportunity to indicate their willingness to participate without any invasion of their privacy. The vast majority of the students, however, had to be contacted through other means. These include (a) contact with socially active members of the adult deaf community to learn of the whereabouts of members of the sample, (b) advertisements in an alumni magazine, (c) checks with community services for the deaf, (d) attendance at social and athletic activities of the Berkeley School, (e) attendance at a reunion of the alumni, (f) a search of news columns and reports on alumni happenings, (g) checks of telephone listings in public directories and in post-secondary schools for the deaf such as NTID, Gallaudet and California State University, Northridge.

Two persons were known suicides. Addresses were not available for 17 other persons (leads on 5 of

these have since been obtained). Two letters were returned, "addressee unknown." On the first round of letters 39 returned the forms with 4 declining to be interviewed. (2 of the 4 also denied researchers' permission to look at past academic records. Personal contact with two of these yielded agreement to participate). On the second round, an additional 21 responded, with 4 refusals. Two wanted more information before they would consent to be interviewed. Personal contact at a school reunion yielded consents from an additional 16 persons.

In all, 65 have agreed to be interviewed so far. Since efforts to locate other members of the sample will continue, there appears to be reasonable probability that more than half of the original group can be studied. Because of cost considerations, interviews have been largely confined to those who have remained in the Bay Area, but staff interviewers are planning at least one trip to the East Coast, and one to Oregon and Washington. Interviewing began in the Fall of 1978 and will continue through December of 1979.

The coding scheme is being refined, and data will be analyzed after completion of the interviews. It is expected that a separate paper on the modification and reliability of the Self-Concept scale will be prepared, if the data warrant.

APPLICABILITY: The information thus made available to schools and rehabilitation personnel may permit them to modify their practices in such ways as to improve the chances for vocational success for deaf clients.

283 Improving the Effectiveness of Psychotherapy for the Deaf (formerly: Crucial Variables in the Clinical Effectiveness of Personnel Who Work with the Deaf)

Principal Investigator:	Hilde S. Schlesinger, M.D.	
Status:	Continuing	
Dates:	October 1977-September 1981	
Cost:	Annual \$25,638 RT Annual \$25,638	Projected Total \$194,000 RT % of Annual 100%
Annual Report Reference:	#2, Page 59, R-2	

OBJECTIVES: To review literature on psychotherapy with the disadvantaged and with impulsive characters to note similarities with psychotherapy with the deaf.

To conduct an "experience survey" to learn about common features of psychotherapy with the deaf.

To survey a number of deaf adults about their views on psychotherapy and mental health with a view ultimately to making a film to orient deaf adults to psychotherapy and mental health principles.

Eventually, based on the above, to produce a film that will help deaf adults understand when psychotherapy is useful, what its aims and methods are, and to educate them about some elementary notions of mental health.

METHODOLOGY: As a first step, surveys of the literature were conducted on (a) the effect of psychotherapy training, (b) psychotherapy with several different groups, i.e., the deaf, the impulsive, and the underprivileged. Previous research suggests that impulsiveness and low verbal skills are frequently found among deaf persons.

As a second step, the literature on orienting lower-class and nontraditional patients to psychotherapy was reviewed, and on the basis of this review, an interview schedule was constructed and all ten therapists on the staff of our Center were interviewed in depth about their experience and attitudes in working with deaf patients.

Based on the findings of these interviews and on the literature search, we are constructing a questionnaire to administer to deaf adults. The findings from both sets of respondents will eventually be used to form the basis for a film to orient deaf adults to the nature of psychotherapy.

FINDINGS TO DATE: The literature sources surveyed in all cases were the computer stored abstracts compiled by N.I.H. and Psychological Abstracts. The first survey dealt with the effects of Psychotherapy Training. There were 101 indexed references, of which 25 were deemed significant enough to be copied and included in the library of the Center. The success of therapy with selected groups of clients, i.e., the deaf and the impulsive, yielded another 101 referenced articles with 41 deemed important enough to copy. Annotated bibliographies have been prepared for all these areas. A fourth survey, Psychotherapy with the Underprivileged, was completed in August, 1978.

The staff interviews are being summarized, and we expect to publish the results when the analysis is complete. Arrangements are under way to administer the short questionnaire on psychotherapy to a number of deaf young adults.

APPLICABILITY: Since RT-23 is the only RT Center specifically mandated to focus on mental health problems of the deaf, it has an obligation to other centers, to the deaf community, and most immediately, to deaf patients to help make that therapy as effective as possible. It has been observed that many deaf people fail to seek therapy because they have fears about it and believe that going into psychotherapy is only for people who are severely disturbed. As a result, some of the people who could most benefit from treatment do not get seen. Furthermore, among those who do come, there is a relatively poor attendance rate, along with frequent tardiness, early drop-out. Both the deaf community at large and those particularly at risk need to have psychotherapy "demystified" for them so that the prospect will be less threatening, and so that problems are presented in earlier stages before they become disabling and thus even further compound the disability of deafness itself.



**University of North Carolina at Chapel Hill (RT-24)
Blindness Rehabilitation Research and Training Center**

PROGRAM INFORMATION

This year the University of North Carolina at Chapel Hill received a five year \$1.5 million grant to establish the first national research and training center on rehabilitation of the blind and severely visually disabled. Under the direction of Thomas S. Baldwin, Ph.D., the center will primarily focus on employment of blind adults and gradually broaden efforts to include problems associated with blindness throughout the entire life span. Programs will fall into three core areas: evaluation of current and future technological aids, development of ways to maximize residual vision, and psychological and sociological research into the support systems available to blind persons and development of psychological tests to help the blind identify jobs for which they are best suited.

University of North Carolina at Chapel Hill
Blindness Rehabilitation Research and Training Center
210 N. Columbia Street
Chapel Hill, North Carolina 27514

RT-25

Boston University (RT-25) Mental Health Research and Training Center

PROGRAM INFORMATION

The Department of Health, Education, and Welfare recently granted \$300,000, renewable each year through 1983, to Boston University's Sargent College of Allied Health Professions to establish the first mental illness rehabilitation research and training center. Its programs will produce new knowledge to improve rehabilitation methods of alleviating or stabilizing mental health-related handicapping conditions, assist in successfully deinstitutionalizing mentally ill persons, and promote social, emotional, and economical independence to prevent institutionalization and enable those who are mentally handicapped to live as productively as possible in the least restrictive environment.

William A. Anthony, Ph.D., is the Project Director.

Boston University
Rehabilitation Research and Training Center in Mental Health
Sargent College of Allied Health Professions
Boston, Massachusetts 02215

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